This is to certify that the

dissertation entitled

Perceptions and Behavioral Responses of Anglers to the Presence of Toxic Chemicals in Michigan Rivers

presented by

Edward Udd

has been accepted towards fulfillment of the requirements for

Ph.D degree in Park and Recreation Resources

Joseph D. Fridgen
Major professor

Date 11-11-85

PERCEPTIONS AND BEHAVIORAL RESPONSES OF ANGLERS TO THE PRESENCE OF TOXIC CHEMICALS IN MICHIGAN RIVERS

By

Edward Udd

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Park and Recreation Resources

1985

ABSTRACT

PERCEPTIONS AND BEHAVIORAL RESPONSES OF ANGLERS TO THE PRESENCE OF TOXIC CHEMICALS IN MICHIGAN RIVERS

By

Edward Udd

Chemical substances which are known to be hazardous to people are being released into the environment daily. The living and working environments of many people are often converted into areas of well documented health risks. Recreation environments are not immune from toxic chemical contamination. Anglers who consume fish caught from contaminated waters may be endangering their health. The Michigan Department of Natural Resources (MDNR) has recognized this hazard and has implemented an information dissemination program targeted at anglers. The assumption is that anglers will use the information to protect their health. This expectation parallels the action of many public agencies in their efforts to warn the public of the dangers of other types of natural hazards. The primary premise of such action is that the public will behave in a predictable, rational manner when presented with correct information about the hazard. Predictions for how people will behave given correct information can be found in the natural hazards literature. This study focuses upon the applicability of those predictions to the recreation

environment contaminated by toxic chemicals. There were three main findings in this study: 1) anglers did not accurately perceive the level of toxic chemicals present in the waters they were fishing and in the fish they were catching. 2) anglers did not minimize their risk from toxic chemicals by taking precautionary actions even when they did perceive that toxic chemicals were present. 3) the expectation that the public will make decisions that parallel the economic rationality decision model was not supported. The implications of the study are: 1) public agencies need to explore new techniques for disseminating information about toxic chemicals to anglers. 2) the expectation that the public will respond in an economically rational manner to correct information is misleading and public agencies should not expect such results. 3) anglers are being exposed to a health risk from contaminated fish due, in part, to the ineffectiveness of the present information dissemination program.

To Mary, with love.

ACKNOWLEDGMENTS

As with all dissertations, this one was not completed without considerable help from many people. My appreciation for their thoughtfulness and consideration is deep and sincere and I wish to take a moment to thank some of them at this time.

First of all, I wish to express my appreciation to my fellow graduate students both former and still trying. No one can understand the exasperation and frustration of the graduate student process like a fellow graduate student. Their empathy and support provided a helping hand whenever it was needed. I would particularly like to thank the following people: Dave Safronoff, Dave Feltus, Gene Brothers, Tish Neumyer, Hideo Kikuchi, Bill Norman, Bob Slana, Dave Klenosky and Marci Cobb. And a special thanks to Cindy Deale who shared a good deal of my work and efforts.

I would like to thank all the staff in the department both former and present, and particularly Char, Betty, Denise and Marcia. Their everyday kindness and helpfulness made each day a little easier.

I would also like to thank the entire faculty as each and every one of them has made the effort, at one time or

another, to share some insights about a problem, to give a word of encouragement or to simply share a word or two. I would like to particularly mention Don Holecek, Dan Stynes, Jim Bristor, Maureen McDonnough, Ted Haskell, Rick Paulsen, Malverne Winborne and Lou Twardzik for their specific help, attention and opportunities presented.

I especially want to thank the members of my graduate committee for their time and commitment in seeing this dissertation through to its completion. I would like to thank Dr. Martin Block for teaching me most of what I can say I know about statistics and his help in putting together a solid sampling design. I would like to thank Dr. Bob Marty for reigniting my interest in learning when I did not think I would <u>ever</u> get excited about taking a class again and for his help in thinking through some major issues and concerns.

I would also like to thank Dr. Dennis Propst for his help in making this dissertation the best it can be and for not settling for less than my best effort. His insightful comments and suggestions have often led me to new heights of travail and, consequently, to new plateaus of accomplishment.

Lastly, I would like to thank Dr. Joe Fridgen who as my committee chairman, advisor and friend has had the major influence on my doctoral career. I cannot hope to repay all the stress, frustration and persistence that went into the

process of molding me into a doctoral candidate, but any successes I have, small or large, will reflect Joe's faith and belief in me.

This research project was funded in part by a grant from the Center for Environmental Toxicology, Michigan State University and the Agricultural Experiment Station, Michigan State University, Project #1436-H, "Psychology of Recreation and Tourism: The Relationship between the People and the Resource," Joseph D. Fridgen, Principal Investigator.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The relationship between people and the environment is dynamic. As the environment changes, people adapt. When the environment is not suitable, people modify the environment. Oftentimes these modifications are for the better. Sometimes these modifications lead to unfortunate side effects such as the destruction of habitats for wildlife, air pollution, unrestored and exhausted strip mines, acid rain or toxic wastes and spills. These impacts are unfortunate in themselves, but they can also affect the people who create the problem, as well as others.

This study looks at one relationship between people and the environment: anglers and toxic chemicals. Anglers are simply those people who fish for sport. Toxic chemicals are those substances which have been defined by State and Federal government agencies as presenting a public health threat. The relationship is important because anglers may be exposed to hazardous levels of toxic chemicals when they consume contaminated fish.

Governor Blanchard in his State of Michigan message (1985) recognized this problem: "... Hundreds of chemicals and heavy metals have been found in the Great Lakes, raising concern about this little understood pollution problem. Fish can concentrate these contaminants by many thousands of times, enabling us to detect them." (p.34).

Toxic chemicals raise such levels of concern because they are known to be a cause of cancer and of birth defects, as well as lesser health problems such as nausea and severe headaches (Burmaster, 1982; MDNR, 1984b; Collins, 1978; Schweitzer, 1983; Holdgate, 1982; Eckholm, 1982; Logue et al., 1981). The Michigan Department of Natural Resources and the Michigan Public Health Department recognize the risk of toxic chemicals to anglers and have jointly published a warning about toxic chemicals in certain Michigan rivers as well as the Great Lakes. This warning is printed on the Michigan Fishing Guide (MDNR, 1984a) available to anglers when they purchase a fishing license.

Limited research exists on the relationship between anglers and toxic chemicals. In this study, findings from the natural hazards literature are used to predict how anglers will respond to the presence of toxic chemicals in the waters that they are fishing. These predictions are based on the assumption that anglers will respond to the presence of toxic chemicals in the same way that people respond to such natural hazards as: air and water pollution, floods, earthquakes and tornados. Some differences exist between the "typical" natural hazard situation and the threat that toxic chemicals pose to anglers. These differences will be discussed later in this chapter.

However, one difference is of enough concern to discuss at this point; due to the inherent nature of toxic chemical contamination, the chemicals are not detectable by any of the human senses in the levels they are usually found in the environment. For this reason it cannot be automatically assumed that people can "perceive" the presence of the hazard: toxic chemicals. Thus, this study also examines the question of the perception of toxic chemicals by anglers as well as their behavioral responses.

The remainder of this chapter will review the literature as it pertains to leisure and fishing experiences, toxic chemicals in the environment, and natural hazards. These literature bases establish the foundation for the approach taken in this study, help articulate the problem statement and provide the background for the hypotheses which appear at the end of this chapter.

Leisure

Even though "leisure" time has existed almost from the dawn of human creation, debate still continues today as to how to define leisure. "Lurking in the shadows of most all research into whatever aspect of leisure is the question: What is leisure?" (Harper, 1981, p. 113). Leisure can be defined as a specific type of activity. By definition then, such activities as boating, skiing, backpacking, walking etc. as a group make up the term "leisure".

However, such an approach has some difficulties. What is leisure for one person may be work, or worse, for another. For example, a couple may both be cross-country skiing. For one the experience is totally enjoyable. The other, however, may only be participating to please the first or because the first forced the other to go. The "experiences" of the two are totally different even though they are participating in the exact same activity.

Another conceptualization of leisure, and the one used in this study, is that leisure is an experience rather than an activity or a type of behavior (Harper, 1981; Gunter, 1979). An experience, unlike an activity, has a cognitive component in addition to the behavior itself. For example, two individuals may be participating in the identical activity, but the psychological outcome of that activity may be entirely different for each of the individuals (Driver and Brown, 1978). Using this definition, two individuals who are fishing under identical conditions may be receiving two entirely different types of leisure experiences as mentioned above. One may feel that the fishing experience is an excursion into very primitive natural conditions, while the other may feel hemmed in by the signs of other anglers and civilization. Both are participating in the same activity, but each is receiving a unique leisure experience.

In addition to leisure as an experience it is important to keep in mind that leisure is voluntary in nature. "Of all the characteristics of the leisure experience, there is probably none more 'obvious' than the assumed freedom to choose the desired activity in the use of one's time" (Gunter, 1979, p. 16).

This point is emphasized because anglers are participating in a leisure experience. The "freedom" characteristic of leisure means they are relatively free to choose where to fish, when to fish and even whether to fish. If they are forced to fish they are not participating in a leisure experience. For this study this simply means that anglers are free to fish or not to fish in waters that contain toxic chemicals. This freedom of choice, of course, depends on anglers knowing where toxic chemicals are to be found. If they cannot perceive the presence of these chemicals then they cannot make knowledgeable choices in attempting to avoid contaminated areas. The ability of anglers to perceive the presence of toxic chemicals is of central concern in this study.

A system which evolved from the concept of leisure as an experience is the Recreation Opportunity Spectrum Land-Use Classification system (ROS). Driver and Brown (1978) describe how various types of settings lead to opportunities for specific types of recreation experiences. In their study, settings range from primitive to urban in nature.

The basic tenet of the ROS system is that specific types of settings are most appropriate for specific types of recreation experiences. Thus, the environment, which includes social and managerial factors as well as physical factors, plays some role in what people will experience from their leisure activities.

Clark and Stankey (1979) used the ROS system to describe how Lake Kachess in Washington evolved over time from an area initially offering primitive leisure experiences to an area offering urban leisure experiences. The reason for this evolution was due to managers responding to changing use patterns at the lake. For example, initially a wagon road was built to provide access to the lake. The improved access led to more people using the area. Improvements were made to accommodate this increase in use which, in turn, led to greater use and increased development. What was once an area suitable for primitive use became an area suitable for urban-type use. As the environment changed so did the type of use.

The sensitivity of people to changes in their leisure environments gives impetus to this study. Toxic chemicals are not normally found in hazardous amounts in undisturbed environments. The presence of toxic chemicals might lead to changes in recreation experiences in the affected environment.

Hazards in the recreation environment present a unique managerial problem. Some recreation activities involve certain risks that are part of the recreation experience (Cheron, et al., 1982). One way of removing all risk from the sport of, say, rock climbing would involve the removal of all vertical slopes and all rocks. Without question, such actions would dramatically change the rock climbing experience. The regulation of recreationists, even for their own protection, goes against the voluntary nature of leisure and recreation. "Recreation and visitor regulations are inherently contradictory. Recreation is a voluntary, pleasurable, rewarding activity, based on free choice, while regulations are designed to restrict free choices" (Lucas, 1982, p. 148). A balance needs to be struck between freedom and regulations created to protect the safety of recreationists.

When a hazard is readily apparent and avoidable by the type of recreationists who use an area, regulation need only be minimal. However, "... When a real hazard is perceived as being minimal or nonexistent, a much more intensive management program is required" (Jubenville, 1978, p. 150). In other words, recreation managers need to regulate recreationists when recreationists cannot perceive real hazards that are present. As already mentioned, people rely on their senses to detect environmental hazards, but their senses cannot directly perceive the presence of toxic chemicals. This presents a situation where some regulation by recreation managers is desirable.

From a legal standpoint, a hazard such as toxic chemical contamination constitutes a hidden danger. The public cannot be expected to know of the presence of toxic chemicals without some notice or warning from the managing agency. The minimum legal duty of a recreation manager is to provide the public with adequate warnings about the presence of hazards that they would normally not be expected to know about (Marty, 1982, p.94). Failure to do so may lead to the recreation agency being liable for any subsequent injuries to anglers who fished on their lands.

When choosing to regulate, recreation managers need to determine the degree of intervention, from both legal and practical standpoints, necessary to alert the public. Lucas (1982) states that this leads to a choice between "soft" and "hard" management. Soft management would choose the type of regulation that has the least impact on the recreation experiences of the public being regulated. One example of this type of management would be the publication of a warning on a pamphlet that would receive wide distribution. This is similar to the approach taken by the Michigan Department of Natural Resources with its publication of warnings about toxic chemicals in its <u>Michigan Fishing Guide</u> (MDNR, 1984a).

While it may not be legally mandated, a "hard" management approach may be desirable when people continue to behave in a manner which endangers their safety. A hard management approach might include removing the hazard completely. At this point in time, that would entail the removal of all contaminated fish from contaminated waters. Such a solution, besides being prohibitively expensive, also removes a key element from the fishing experience: catching fish. Less extreme measures might include: blocking access to hazardous sites, creating fines for hazardous acts, increasing the patrolling of a hazardous area, increasing the visibility of a hazard using high density signing methods or closing down the hazardous site(s). In any case, the ultimate goal of the manager is to reduce the risk from the hazard, but each has some impact on the fishing experience.

In summary, leisure is a voluntary experience that is influenced by the recreation environment. When known hazards are present in these environments that are difficult or impossible for recreationists to detect, recreation managers may wish to intercede on the behalf of visitors. This action must balance the desirability of preserving the freedom of the visitor, maintaining the essence of the leisure experience and protecting the safety of the visitor.

Fishing

Fishing is a leisure experience that is at once simple and complex. An angler can be defined as anyone who participates in the act of fishing for non-profit motives. This definition captures the simple essence of fishing.

However, in line with the definition of leisure as an experience, in this study fishing is considered an experience also. In this study, an angler is someone who uses fishing as a vehicle to obtain a variety of recreation experiences. This is consistent with the definition of leisure given above where a recreation activity is not equated with a single recreation experience.

Bryan (1979) describes four types of anglers:

1. Occasional - "those who fish infrequently because they are new to the activity and have not established it as a regular part of their leisure, or because it simply has not become a major interest."
2. Generalist - anglers "... who have established the sport as a regular leisure activity and use a variety of techniques."
3. Technique specialists - "anglers who specialize in a particular method, largely to the exclusion of other techniques."
4. Technique-setting specialists - "highly committed anglers who specialize in method and have distinct preferences for specific water types on which to practice the activity." (p. 33)

These anglers differ from one another in the type of equipment they use, their desire to catch large numbers of fish, the type of fish they are seeking and the type of environment in which they are willing to fish.

Manfredo et al. (1978) used cluster analysis to identify six types of wilderness anglers based on the psychological outcomes they derived from their experiences. For example, the members of the type five group were characterized by their emphasis on experiencing nature and the change of pace that fishing afforded them (p. 293). The other groups differed in the amount of emphasis they placed on various psychological outcomes.

It is clear that there is no single, stereotypical angler. Generally speaking, however, anglers are united by the fact that they go fishing to <u>attempt</u> to catch fish. Success in catching those fish is not essential to the overall enjoyment of the fishing experience. "It would be incorrect to suggest that, in the long run, the size and number of fish caught are not important to fishing enjoyment. In many instances, however, other factors significantly influence fishing enjoyment" (Moeller and Engelken, 1972, p. 1254). "It seems apparent that the nature of the fishing experience goes far beyond the actual taking of fish..." (Hendee et al, 1977, p.4).

Driver and Knopf (1976) suggest that "...It is unlikely that many fishermen would fish waters in which they knew no fish existed. However, many fishermen have had beautiful trips without having caught a fish, and perhaps without having wet a line. Therefore, the satisfaction derived from fishing is dependent on the existence of fish, but goes considerably beyond the actual taking of the fish" (p. 21).

In the study by Hendee et al. (1977), which examined use of alpine lakes in the state of Washington, about forty percent of the anglers studied did not catch any fish at all. In another study, across a 135 day fishing season in South Carolina on a stream stocked with fish, 30 percent of the groups sampled caught no fish at all (James et al., 1971).

In the Moeller and Engelken (1972) study, the single most important factor that influenced the fishing experience was water quality. Out of eight factors rated, the size of fish and number of fish rated fourth and sixth respectively.

In summary, anglers can be characterized as being composed of many types who seek a variety of recreation experiences from fishing. These anglers are united by the goal of catching fish, but success at this task is not always necessary for enjoying the activity. Other characteristics, such as water quality, may play an equally important role in leading to a satisfactory fishing experience.

Toxic Chemicals

The following three quotes give an indication of the scope of the toxic chemical problem:

"Michigan faces an enormous challenge in identifying and controlling the thousands of chemicals and toxic waste sites that may harm human health" (Blanchard, 1985).

"In 1980 a special U.S. government committee on toxic substances characterized the broad challenge: the magnitude of the toxic substances control problem, although not quantifiable with precision, is staggering in view of the number of substances whose risk should be evaluated, the rate of growth in both number and volume of chemicals, the various routes by which humans and the environment are exposed, possible synergistic or combined effects of the substances, and the effects that they cause - acute and chronic, immediate and delayed" (Eckholm, 1982, p. 108).

"Recent concerns in the United States, Canada, and Europe over the increasing number of environmental chemicals that are believed to pose serious problems for human health have led to a flurry of national laws and regulations for the control of chemicals. These laws and regulations are designed to address ecological concerns as well, but actual and potential health hazards have received by far the greatest attention in recent years" (Schweitzer, 1983, p.22).

Toxic chemicals are not a problem peculiar to the state of Michigan. They are a problem across the country and around the world.

It is easy to make a strong case that toxic chemicals are hazardous to human health. As already mentioned in the introduction toxic chemicals are known to cause nausea and severe headaches as well as cancer and birth defects (MDNR, 1984b; Collins, 1978; Schweitzer, 1983; Holdgate, 1982; Eckholm, 1982; Logue et al., 1981). What remains a problem is determining what level of toxic chemicals is acceptable in the environment.

This is a particular problem with water because of the many variables involved in measuring water quality (Ott, 1978). What is perfectly acceptable under one set of conditions is unacceptable under another set of conditions. In addition, there is presently no national standard for what constitutes a hazard for most toxic chemicals (Ott, 1978). "The task of maintaining water quality" ... is... "complicated by increasing amounts of evidence that minute doses of organic substances could injure human health. Refinements in detecting minute quantities of pollutants"... have... "helped uncover the evidence" (Holdgate, 1982, p.163). The levels of toxic chemicals that experts suggest are needed to create a hazard continues to decrease. As our measuring techniques continue to improve, these low levels of toxic chemicals are being detected in the environment.

An illustration of the problem of toxic chemicals can be drawn by looking at Polychlorinated Biphenyls (PCBs). PCBs have the "... properties of nonflammability, stability, resistance to acids, alkalis and other caustic chemicals and low volatility under prolonged heating... (Hesse, 1976, p.127). Some of the uses of PCBs were in "... dielectric fluids in capacitors, plasticizer applications, transformer fluids, hydraulic fluids and lubricants, and heat transfer fluids" (Hesse, 1976, p.127).

The very properties that made PCBs so attractive to industrial use are the properties that make PCBs such a problem when they are spilled into the environment. The chemical structure of PCBs is essentially the double bonding of two phenol rings with several sites available for bonding with chlorine atoms. This chemical arrangement is very stable and resistant to any breakdown.

In addition, there are 209 possible chlorobiphenyl isomers (Mieure, 1976). This simply means that there is not just one chemical structure for PCBs, but 209 possibilities. To counteract the presence of PCBs in the environment using other chemicals to neutralize their hazardous effects is very close to impossible. If it could be done, a total of 209 antidotes would have to be created, each with their known and unknown side effects. There is no proven technology for the removal of PCBs from water and, hence, the emphasis is on preventing PCBs from entering waste water (Kopp, 1976).

Because of possible health effects from PCBs, stricter monitoring of these chemicals is in effect. For example, back in 1976, it was noted that "...because of the potential effects of PCBs on fish and consumers of fish, the Great Lakes Fishing Laboratory in 1977 will incorporate analysis of PCBs with its routine program of pesticide analysis in Lake Michigan fishes" (Wilford, 1976, p. 177).

Polychlorinated Biphenyls present a threat to consumers of fish because PCBs "bioaccumulate" (Train, 1976). Bioaccumulation means that some chemical may exist in trace or even undetectable amounts in water, but fish living in that water build up high levels of the chemical in their body tissues over time. Water that is safe to drink may contain fish that are hazardous to eat because of the bioaccumulation of toxic chemicals.

In short, toxic chemicals present a hazard in the environment. The extent of that hazard is unclear, but it appears that the risk is increasing and is present in waters around the world.

The purpose of this paper, however, is not to examine the health effects that can be attributed to toxic chemicals nor the difficulty in detecting their presence and establishing that a hazard exists; rather, the purpose is to examine the relationship between anglers and toxic chemicals. This relationship can be examined only by being able to define the level of toxic chemicals present in the waters and fish being studied. Without such a definition, it is impossible to talk about anglers' responses and perceptions because the hazard is not accurately described.

The definition of the level of toxic chemicals present in Michigan waters is made possible because the Michigan Department of Natural Resources, in cooperation with the Michigan Public Health Department, has identified which waters in Michigan contaminated by toxic chemicals constitute a threat and which do not:

> "Persons frequently eating fish caught in Michigan waters should be aware of the potential risk of exposure to chemical contaminants which may be present in some species caught in some locations. Contaminants of concern include Mercury, PCB, PBB, DDT, Dieldrin, Chlordane, Toxaphene and Dioxin. One or more of these chemicals have been detected in fish and serve as the basis for the advisory for various bodies of water" (MDNR, 1984a, p.7).

The warning goes on to explain which waters contain toxic chemicals in sufficient amounts to make the consumption of any fish unsafe; which waters have certain species of fish which are unsafe if consumed in large amounts or are unsafe if consumed by high risk people such as expectant women or children under six; and which waters can be assumed to be safe because they receive no mention. The specific rivers used in this study will be discussed in Chapter Two.

In summary, toxic chemicals pose a threat not only in Michigan, but throughout the world. The threat occurs because toxic chemicals endanger human health and those chemicals are present in the environment. Anglers represent a group at risk because toxic chemicals are found in the fish they catch and potentially consume. The state of Michigan has recognized this problem and has identified those waters which are potentially hazardous due to toxic chemical contamination. The waters identified in this warning will be used to define the relative levels of toxic chemical contamination in this study.

Natural Hazards

A natural hazard can be defined "...as an interaction of people and nature governed by the coexistent state of adjustment in the human use system and the state of nature in the natural events system".... "Certain of the hazards are created by man through his alteration of land and water or by his invasion of risky areas; others are exacerbated by his efforts to reduce the risk" (White, 1974, p. 4). Stated differently, people adjust to disturbances in the natural environment. These disturbances may have natural causes such as earthquakes, tornados or floods. They may also be due to peoples' disturbance of the environment such as with air and water pollution. Or, these disturbances may be due to people choosing to be in environments that are potentially hazardous such as building a house on a fifty year floodplain or recreating in an area known to contain toxic chemicals.

Early investigations of natural hazards revolved around the question of why people persisted in occupying floodplains (White, 1974). The driving force behind this early research was that the federal government had invested over $5 billion in flood control efforts starting in 1936 and ending in 1957 only to find a net increase in flood losses during the same time period (White, 1974). Early research efforts soon branched out from simply studying floods to other types of natural hazards as well.

The accumulation of research led to Hewitt and Burton's (1971, p.140) description of four possible behavioral responses to a natural hazard:

1. People avoid the natural hazard.
2. People use mechanical circumvention to deal with the hazard (i.e. the use of a boat to escape from a flood).
3. People cope with the hazard by changing whatever is causing the damage.
4. People adapt to the hazard by accepting what is happening due to the hazardous event.

These four responses form the basis of much of the behavioral prediction research in natural hazards. These four behavioral responses also form the basis for the predictions made in the hypotheses of this study. However, as a precursor to these behavioral responses, it is first necessary that people perceive the presence of the hazard.

Perception

At this point it is important to discuss perception as a key concept before the presentation of the research paradigm for this study. With the study of many natural hazards this is an insignificant issue. For example, in the study of a tornado it is not necessary to first ask if the victims of the event noticed the tornado. When a tornado is present it is obvious and leaves little doubt that it is present.

However, because toxic chemicals are not directly perceivable it is first necessary to establish if people can "perceive" their presence. "It seems likely that the process of choice does not begin until after a first threshold of awareness of actual or anticipated loss is reached" (Burton et al., 1978, p.89). If the threat does not exist in the mind of the angler then questions of behavioral responses cannot be made. This makes intuitive as well as logistical sense. If something is not perceivable then it does not exist unless knowledge of its presence is obtained from some indirect source.

Perception as a field of study is well established and a vast body of literature exists. The oldest school of thought deals with perception as strictly a physiological process (Kolers, 1983). This process was characterized by the reception of real, physical stimuli and a physiological reaction by the recipient to that physical stimuli. This conceptualization led to the study of perception that did not involve any cognitive processing (Kolers, 1983).

More recently, a second school of thought has developed that has dealt "...with perceptual experiences less realistic than those of the traditional topics" (Kolers, 1983, p. 130). In essence, this school of thought deals with perceptual processes that "distort" reality. For example, when a visual stimulus is of a very short duration, say thirty to sixty milliseconds, our ability to distinguish temporal differences is impaired (Haber and Hershenson, 1973, pp. 134-138). Visual stimuli of less than this duration still exist in reality, but are generally beyond our ability to determine the duration of their existence. This principal is what makes moving pictures work. The frames of the movie are moved faster than our ability to detect each individual frame of the movie. What we see is different than what is really present and can be distorted in many other ways as well.

A third school of thought deals with perception as an image that people carry with them (Kolers, 1983). This point of view leads to the acceptance that some sort of cognitive process occurs after the reception of physical stimuli which leads to a reconstruction of what the perceiver actually imagines the stimuli to be. In effect, "... all our modes of experience, perceptual, affective and normative, are brought into action at the same time" (Levy-Leboyer, 1982, p. 46).

This notion leads to an even more complex and difficult conceptualization of perception. Not only is it important to study the physical reception of physical reality it is also important to allow for distortions in that reception and to allow for cognitive processing of the stimuli which may lead to an image that is quite different from reality. These differences are due to the evaluation process by the perceiver of the stimuli as a result of the cognitive processing.

Given this complexity studying perception is very difficult. "The only legitimate approach to it must be that of focusing the spotlight on one of the phases of the perceptual-evaluation process, without forgetting the modulating effects of other aspects" (Levy-Leboyer, 1982).

In this study the focus of study for perception deals with the final product of the entire perceptual process: what is the level of toxic chemicals that anglers perceive in the fish and in the water? Taking this approach does not mean that the whole series of cognitive processes that led to these perceptions is unimportant, rather, studying the final perceptual image is the necessary point of study to determine whether anglers can perceive the alternative choices available to them.

At this point one can begin to examine the relationship between anglers and toxic chemicals. Anglers do not directly perceive the presence of toxic chemicals simply because there is no directly perceivable physical stimulus. However, they may carry an image of the level of toxic chemicals in the environment as a result of indirect stimuli, such as the media, friends and acquaintances, official publications and other sources.

In addition, they may also attribute the presence of toxic chemicals in the environment to other stimuli that they can directly perceive. Barker (1970) found such a relationship while examining water pollution of beaches in the Toronto area. The pollutants in the water could not be directly perceived, but people attributed the level of pollution to the presence of stimuli that they could perceive such as algae or floating debris.

If one chooses water conditions that are roughly equivalent in sensory characteristics it would be expected that these characteristics would not aid individuals in their evaluation of the presence or non-presence of pollutants. In this study, rivers which were roughly equivalent in sensory stimuli were chosen as study sites. Toxic chemicals further parallel the water pollution example by not being directly perceivable.

Decision Making

The decision making process does not begin until the available alternatives pass a perceptual threshold and become perceived alternatives (Burton et al, 1978). In this study, once the hazard is perceived as present then anglers have a whole array of alternatives available to choose from to respond to the hazard.

Before those alternatives are presented, it is necessary to examine the decision making frameworks of anglers. The agency needs to understand, at least in a rudimentary fashion, the decision making frameworks of the public if they hope to influence their behavior. It is also necessary to examine the decision making framework of the managing agency since public agencies often try to influence the behavior of the public.

The two main decision making frameworks of concern here deal with economic rationality and bounded rationality. Economic rationality, as might be expected, conceptualizes decision making as a benefit/cost analysis by individuals (Einhorn and Hogarth, 1981). Bounded rationality can be conceptualized as meaning that each individual uses his/her own individualistic decision making model that may or may not lead to an optimal decision (Einhorn and Hogarth, 1981).

Like perception, decision making involves extensive cognitive processing that is complex. And again, it is not the focus of this study to attempt to explain all these complexities as they relate to toxic chemicals and anglers. The key issue is that the two decision making models lay the groundwork for how public agencies expect the public to behave and provides an alternative explanation of how the public behaves in decision making situations.

In the case of natural hazards, such as toxic chemicals, it has been shown repeatedly that public agencies assume that the public utilizes the economic rationality model in decision making (Slovic et al, 1974). The economic rationality model assumes that an individual will be aware of all costs and benefits associated with all the available alternatives. It is then assumed that the decision maker will choose the alternative that will lead to the highest benefit/cost ratio (Payne, 1982).

There is considerable debate whether bounded rationality is really just an extension of the economic rationality model or a separate model in its own right (Einhorn and Hogarth, 1981). This paper differentiates between the two model types because of the ample evidence that people generally are not capable of assessing benefit/cost ratios accurately because of less than perfect information (Payne, 1982, Slovic et al, 1974). The bounded rationality model predicts that individuals will make decisions that they feel benefit themselves the most, but that these decisions may not be the optimal decisions predicted by the economic rationality model.

The general situation with natural hazards is that public agencies attempt to protect the public using the assumption that the public makes use of the economic rationality model (Slovic et al, 1974). Using this sort of decision framework, public agencies expect the public to respond as if it had perfect information and in a way to best protect their health. If the public does participate in a manner paralleling economic rationality then specific behaviors can be anticipated such as those described above for responses to natural hazards. The bounded rationality model suggests that such rational, predictable behavior cannot be anticipated and expecting the public to behave in such a manner is in itself not rational.

Such a scenario has been tested extensively in the natural hazards literature and a discussion of the relevant literature follows the presentation of each hypothesis. In short, while decision making is complex and involves many cognitive processes this study focuses on the expectation of specific behavioral responses that result from adopting the economic rationality model. The bounded rationality model is presented as an alternative model for explaining behavioral responses.

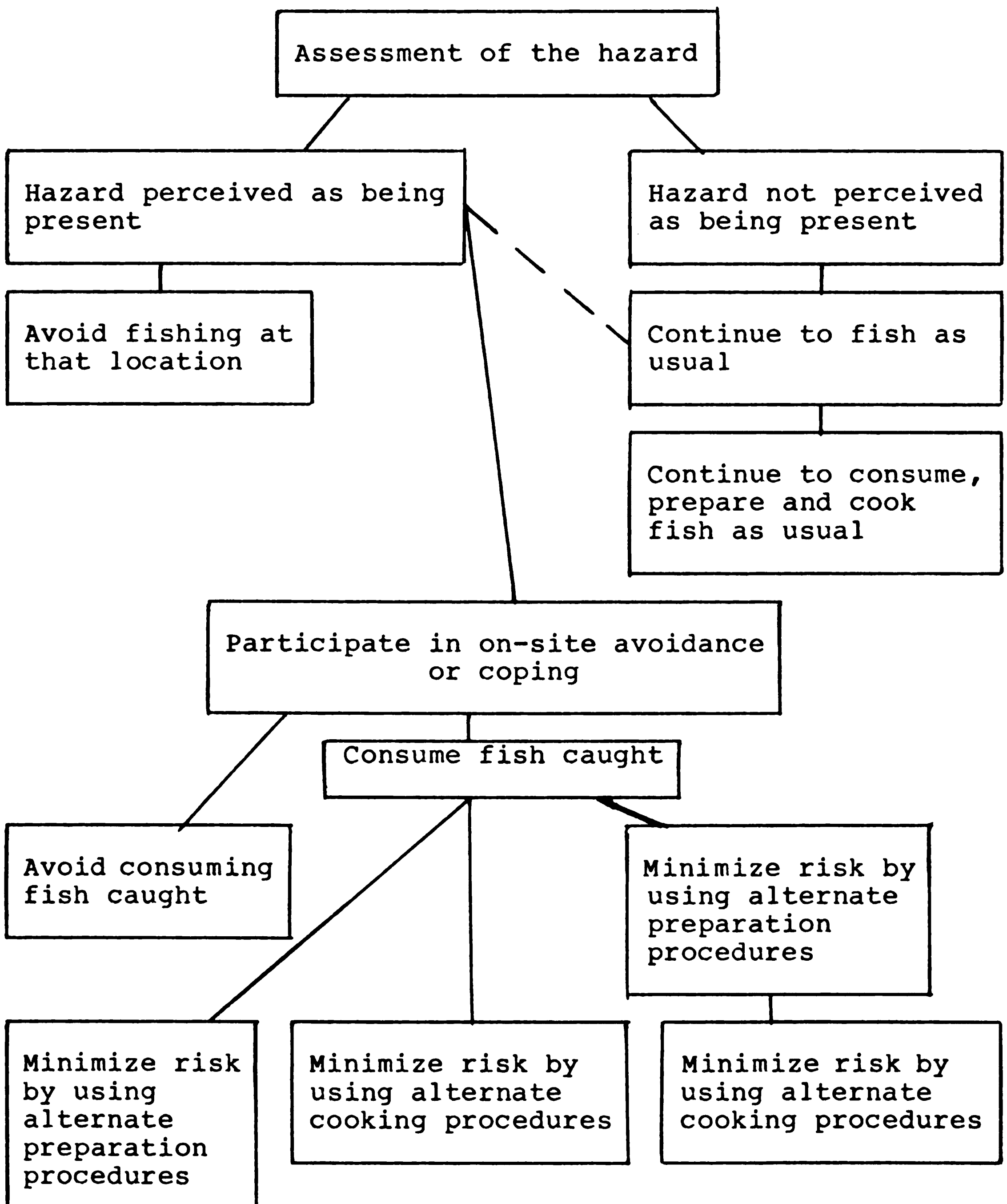
<u>The Response Alternatives</u>

The above information provides a skeleton for creating a "decision tree" for the response to toxic chemicals by anglers. A decision tree simply represents the choices available to a person confronted with a specific decision. It is generally more detailed than the one presented here because it tries to represent all the cognitive processes that are involved before the actual alternatives are confronted. In this study, the focus of attention is on the behavioral responses of anglers to toxic chemicals and not on the cognitive processes of decision making. Hence, those processes are not depicted.

Figure 1 represents a possible decision tree for anglers confronted with toxic chemicals. This decision tree

Figure 1

Decision Tree for Anglers Confronted by Toxic Chemicals



is modeled using the four behavioral responses provided by Hewitt and Burton (1970). The model also recognizes the importance of perception in the study of toxic chemicals and uses part of the decision tree model described by Svenson and Fischhoff (1985).

Figure 1 starts at the point where the initial decision about the presence of toxic chemicals is being made. This ignores all the information gathering processes that went into the formation of this perception. This is not to downplay the importance of those processes, rather it is necessary to focus in on specific points to create a study that is researchable.

It should also be noted that decision making theory only plays a role, in this study, insofar as creating expectations within a public agency for specific behavioral responses by the public. In this case, the expectation of the agency is that the public will take precautions to protect themselves once they perceive the presence of toxic chemicals.

If toxic chemicals are not perceived as being present it would be expected that there would be no change in behavior. In this study that would be represented by people fishing as usual. If toxic chemicals <u>are</u> perceived as being present then people have the option of responding or not responding.

Anglers have four response choices to toxic chemicals: avoidance, mechanical circumvention, coping or adaptation. Mechanical circumvention is not included in the model as such circumvention is not possible with toxic chemicals at this time.

Anglers can avoid the threat from toxic chemicals in fish by not fishing at contaminated locations, by not consuming the fish they catch or by reducing their consumption of contaminated fish. Anglers can cope with toxic chemicals in fish by modifying their preparatory and cooking behaviors to minimize the amount of toxic chemicals they consume. Lastly, anglers can choose to continue to fish as usual.

Figure 1 represents the decision tree of anglers without any mention of optimality. There is no inherently "right" path of choice. The problem for this study arises because a government agency (Michigan Department of Natural Resources) is attempting to change the behavior of anglers who are confronted by a hazard (toxic chemicals). The preferred path, as defined by the MDNR (1984a), is that anglers modify their fish consuming behavior when fishing on waters contaminated by toxic chemicals.

This directly parallels the initial impetus for all natural hazards research: the government creating programs to reduce the risk from natural hazards by attempting to modify the behavior of the public at risk (White, 1974). It has been found repeatedly that the desired modifications in behavior may not occur.

This discrepancy is discussed at length by Slovic et al. (1974). The discussion revolves around the differences in the decision making environments in response to risk between managers and the managed public. The first environment (management) can be described as often following the tenets of the maximization of expected utility. The second environment (public) can be described as following the decision making framework of bounded rationality.

The points of contrast to be considered are those dealing with rationality and probability. The economic rationality model "... assumes that the rational decision maker wishes to select an action that is logically consistent with his basic preferences for outcomes and his feelings about the likelihoods of the events upon which those outcomes depend" (Slovic et al., 1974, p. 188). "The theory of bounded rationality, on the other hand, postulates that decision makers do not think probabilistically and that they try to avoid the necessity of facing uncertainty directly. Likewise they avoid the problems of evaluating utilities and comparing incommensurable features. The goal of the decision maker is assumed to be the achievement of a satisfactory, rather than a maximum, outcome" (Slovic et al., 1974, p. 190).

In short, the expected utility model assumes that the public will make decisions in a rational fashion that will lead to an action that represents the highest probability of maximizing personal utility. Bounded rationality suggests that people do not always act in a rational fashion and that they have difficulty in accurately determining the real probabilities of an event.

The managerial actions of the MDNR mimic the expected utility model. The public is provided with information about the presence of toxic chemicals and the appropriate behavioral responses. Given this correct information it is assumed that anglers will behave in a manner to reduce their risk from toxic chemicals.

In summary, when confronted with the presence of toxic chemicals anglers have several response choices. The MDNR is trying to guide those choices in a direction that minimizes the risk of toxic chemicals to anglers. Two decision making models, that of expected utility and bounded rationality, are presented as representing the decision making processes of the MDNR and the public.

Problem Statement

As with all environments, recreation environments are not immune from common problems of civilization such as: air pollution, acid rain, radioactive materials or toxic chemicals. As with other hazards created by humans, when these hazards present a real danger to recreationists precautionary measures must be taken. When a hazard, such as a short metal stake hidden by tall grass, is present, it is the duty of the managerial agency to warn the public from this hidden hazard or risk being held liable for any accidents. In a similar way, when a hazard, such as toxic chemicals is in the recreation environment, it is the duty of the managerial agency to warn the public or risk being held liable for any accidents.

It has been found that managing agencies, in general, attempt to protect the public from natural hazards by adopting economic rationality as the model for expected public decision making behavior (Slovic et al, 1974). Possible problems result when the decision making environments of managing agencies do not match the decision making environments of the general public (Svenson and Fischoff, 1985). A decision tree (see Figure 1) was created to help illustrate the possible paths of decision based on the perception that toxic chemicals exist in the environment.

Toxic chemicals in the environment represent a problem similar to the presence of other natural hazards in the environment. Because of this similarity, the natural hazards literature is used to provide predictions as to how anglers would be expected to behave in the presence of toxic chemicals. As with a great deal of natural hazards literature, attempts to protect the angler in Michigan from the dangers of toxic chemicals rest on the assumption that the angler uses the economic rationality model in his/her decision making process. This assumption leads to providing the public with correct information with the expectation that this information will lead to optimal decisions in minimizing the risk from toxic chemicals.

This study first looks at the question of whether anglers can differentiate between sites containing different levels of toxic chemicals. The ability of the public to perceive these differences is essential to the initial choice process. If no alternatives are perceived, then there is no choice. The level of toxic chemicals may vary, but if anglers cannot perceive any differences then they do not have any alternatives to choose from and they cannot respond to the presence of a stimulus with which they are not aware.

Of those anglers who do perceive the presence of toxic chemicals, the desired behavioral response is that they will choose the alternative that will best protect their health. This is similar to the expectation that once a person is informed that a stake is hidden in the grass that they will avoid injuring themselves on that stake. This study examines the behavioral responses of anglers to the perceived presence of toxic chemicals in their fishing environment.

To accomplish this purpose, the behavioral predictions made in the natural hazards literature are tapped. Since the relationship between toxic chemicals and anglers has not been previously studied in the natural hazards literature, the hypotheses for this study have assumed that anglers will behave in a manner consistent with the economic rationality decision making model. Being aware of the presence of toxic chemicals should lead to behaviors which will minimize the risk from those toxic chemicals.

In essence, this study examines whether the natural hazards literature provides a theoretical structure for examining toxic chemicals as a hazard in recreation environments. The hypotheses for this study follow.

Hypotheses

Hypothesis 1

Anglers will perceive real differences in the level of toxic chemicals present in their fishing environment when real differences exist.

Before anglers can respond to the presence of a hazard they need to be able to perceive its presence. Three different conditions of toxic chemical contamination were used in this study to examine this issue. This hypothesis represents the desired outcome of an information program developed by the Michigan Department of Natural Resources.

The study of these initial perceptions is not unusual in the natural hazards literature. For example, Mitchell (1974) found "... in a series of studies of air pollution in British cities, it was concluded that many types of pollutants are not easily detected by the human senses until they reach chronic proportions" (p. 329). Similarly, Barker (1970) found that for beach users that "In response to the question 'How can you tell if the water is polluted?' more than half (56%) evaluated water quality on the basis of appearance ... another 15% thought that odour was significant ... Only a few beach users felt that pollution could not be seen while 23% of the cottagers stated that pollution was invisible and that impurities could be identified only by scientific analysis" (p. 40).

Accurate perceptions about the presence of toxic chemicals are needed before the economic rationality model can be said to be working. This hypothesis simply states that anglers will have access to the information about the real levels of toxic chemicals present in the waters they are fishing.

Hypothesis 2

For those who perceive the presence of toxic chemicals, as the real level of toxic chemical contamination increases the number of anglers who consume the fish they catch will decrease.

When confronted with the presence of toxic chemicals it would be expected that anglers would not consume them. The best scientific evidence available shows that the consumption of such chemicals is dangerous. A decision maker who understands this would not be expected to consume fish containing hazardous levels of toxic chemicals.

In similar instances where poisonous substances were present in animals to be consumed considerable avoidance behavior occurred. The following two economic studies deal directly with avoidance of game contaminated by toxic chemicals. In the first, Shulstad and Stoevener (1978) examined the avoidance cost of mercury contamination in pheasant in Oregon. They determined that the net loss to the state was $1.35 million. They concluded "... it is especially important that, through continued research, information flows be improved so that the decisions of both private and public decisionmakers are as well-based as possible" (p.48).

Swartz and Strand (1981) studied the avoidance cost of imperfect information. In this study oysters from the James River were contaminated by kepones and the harvest of those oysters was prohibited. The news of the contamination deflated the market for <u>all</u> oysters in the area even though the oysters that reached the market place were from uncontaminated sources.

The importance of these studies is that toxic chemicals do lead to avoidance behavior by the public. Avoidance is one of the four possible behavioral responses outlined earlier by Hewitt and Burton (1971). It also suggests that people are responding in a manner consistent with protecting their health.

Hypothesis 3

For those who perceive the presence of toxic chemicals, as the real level of toxic chemicals increases so will the number of anglers who participate in coping behaviors.

Again, the direction of this hypothesis is predicted by the desired results of the MDNR information program. Coping behaviors form another one of the categories mentioned by Hewitt and Burton (1971). It is different from avoidance behavior in that people participate in a hazardous event or activity, but they take active measures to minimize their risks. For example, a person may choose to live on a floodplain but builds their house on stilts to minimize the damaging effects of floods.

Sims and Baumann (1983), in a review of the literature found little evidence to support a causal relationship "... between education and awareness and between awareness and behavior..." (p. 167). However, the authors point out that there are exceptions to their findings. They conclude "The question then is, What influences an individual to adopt a measure that will reduce his or her vulnerability? The answer is that little is known; past research is suggestive and offers at best, some general directions or guidelines" (p. 184).

Hypothesis 4

Anglers who have had negative experiences with consuming fish contaminated by toxic chemicals in the past will participate in coping behaviors at a higher rate than anglers who have not had such experiences.

Hanson et al. (1979) studied the long term effects that a devastating tornado in Flint, Michigan had on the coping behaviors of people who had experienced the tornado and who still lived in the area. The main finding of the study was that the effect on coping behavior was striking even after a period of over twenty years.

Baum et al. (1983), in an extensive discussion about the differences between natural hazards and technological catastrophes, suggest that technological hazards may have particularly long lasting psychological consequences. Their rationale was that the duration of the ill effects of such hazards are unknown.

Sims and Baumann (1983) in their review of the literature disagree with the above conclusions. "The facts are that hazard experience is only sometimes efficacious in evoking subsequent preventive measures and then only under certain circumstances and often only for short periods" (p.171).

Hypothesis 5

Anglers of high socioeconomic status will be more accurate in their perceptions of toxic chemicals than anglers of low socioeconomic status.

Mitchell (1974) found that age and socio-economic status were most closely correlated with awareness of various air pollutants. Mitchell felt that older, higher status people were most likely to read or pay attention to media sources. Hence, this group of individuals would be most likely to receive the messages of any educational efforts.

METHODS

This chapter is divided into three sections. The first deals with sampling, the second deals with analysis and the third deals with the operationalization of the hypotheses. The sampling section is given particular attention as the population being sampled is not drawn from a list or a definitively described population.

Sampling

Moser and Kalton (1972) describe two types of populations in sampling: target populations and survey populations. The target population deals with the population of interest and the one that the researcher would most like to represent in the sample. The survey population deals with the population that is actually obtained in the study and is usually at least somewhat different than the target population. The ideal is to minimize the gap that falls between the two types (Moser and Kalton, 1972).

The target population for this study is represented by all anglers who fish in Michigan. This population was broken down into three groups. One group was those anglers who fished in rivers containing levels of toxic chemicals which made all fish unsafe to eat. The location for this group corresponded to those rivers which received the highest level of warning published on the 1984 Fishing Guide (MDNRa, 1984). The second group was those anglers who fished in rivers where the number of fish considered unsafe to eat was not all inclusive. The location for the second group corresponded to the next level of warning published in the same 1984 Fishing Guide. The third group was composed of those anglers who fished on rivers where all fish were considered safe to eat. The location for this group corresponded to those rivers which were not listed in the 1984 Fishing Guide.

The actual survey population used, however, was much more limited than the target population described above. The survey population is described in more detail later in this section.

Several sampling methods were considered for this study. Simple random sampling was the preferred alternative. A list of anglers who purchase fishing licenses was available. However, there is no list of all people who fish in Michigan. This was due to two reasons. The first is that not everyone who fishes obtains a fishing license. The second is that spouses may fish off one license.

It was important to have the people interviewed directly confronted with the conditions of the study. This was done to minimize the problems associated with recall of the stimulus of interest over uncontrolled amounts of time. Such problems are not easily addressed by a mail-out survey. A mail-out survey would also be expected to have a lower return rate than personal interviews in addition to the time and memory problems.

Cluster sampling was also considered for this study, but was rejected because of the difficulty of identifying identical clusters on the chosen sample sites. In general, cluster sampling is used in urban settings to minimize the time necessary to obtain a random sampling. Its usefulness in this study would have been limited.

In the end, a stratified, systematic sampling design was chosen. Stratification is used to ensure that various elements of the target population are adequately represented in the survey population. In stratification "...An attempt is normally made to ensure that each subgroup or stratum in the population is constructed in such a way that the individuals or elements within a stratum resemble one another" (O'Muircheartaigh, 1978, p. 16). "Each subpopulation or stratum constitutes a group to which the researcher may wish to generalize results" (Drew, 1980, p. 189).

Three types of rivers were needed for this study. Randomly drawing three rivers in Michigan would not necessarily lead to the selection of the types of rivers desired. Further, the study sites were chosen on the basis that they were free, public access sites located within fifty miles of moderate size urban areas (populations >

50,000). This was done to minimize the economic barriers that fees and distance would place on anglers who wanted to fish.

The "...procedure of taking every i^{th} case is widely used by professional samplers and is called systematic sampling. Because of its simplicity and usefulness in complex sampling situations, systematic sampling is probably used far more frequently than simple random sampling." (Sudman, 1976, p. 52). "In general this type of sampling ... differs from simple random sampling in that it does not give all possible samples of size n from the population of size N an equal chance of selection" (Moser and Kalton, 1972, p. 83).

Generally speaking, systematic sampling is used when lists are available of the target population. However, the method is also used in field studies. The problem with using this method is that it assumes that people appear at a location in random order (Bailey, 1978, p. 78). "...Systematic sampling can suffer from periodic fluctuations in the population list but this is not a common problem. If the periodic structure of the population is known, a systematic sample can usually be designed to capitalize on it." (O'Muircheartaigh, 1978, p. 17).

Sudman (1976, p. 52) suggests that only two things are needed for systematic sampling: a random start and a sampling interval. When a list is not available Bailey

(1978) suggested that if people descend upon a location in a linear fashion then a random start could be used and an interval chosen that would allow the completion of the study.

The choice of an interval is designed to minimize the chance for autocorrelation in the sample (Sudman, 1976, p. 57). This means that one event should not have any relationship to a neighboring event. For example, when taking surveys in the field one should not take more than one survey per group unless group interactions are a primary focus of the study.

Preliminary field work identified three rivers which met the conditions of the sampling scheme: the Saginaw, the Kalamazoo and the Grand. The Saginaw represented the high toxic chemical contamination condition, the Kalamazoo represented the middle condition and the Grand (where sampled) represented sites with no warnings about toxic chemical contamination.

Two different sampling conditions were present at the sites used. One situation had anglers fishing along the banks of the river. The other sampled anglers who used public boat ramps. The sampling period of six hours was equally divided between these two conditions.

Preliminary field work also indicated that most people fished during the evenings and on weekends. A sampling schedule was drawn up that sampled every Wednesday, Friday, Saturday and Sunday from July 1st through Labor Day during the summer of 1984. On Wednesdays and Fridays the sampling periods were between the hours of 3 and 9 PM. On Saturdays the six hour sampling periods were randomly drawn from the hours of 9 AM to 9 PM. On Sundays the six hour sampling periods were randomly drawn from the hours of noon to 9 PM. These times were based on the heaviest use by anglers on the chosen sites.

The location of the sample sites to be sampled each day were drawn on a random basis. The sites used are shown in Appendix A.

Sample Size

A review of the natural hazards literature showed studies with as few as 67 respondents. Bailey (1978, p. 84) suggested that 100 is the minimum acceptable to many researchers. No previous studies were found that dealt with the perception of toxic chemicals by anglers, so an estimate of the sampling error was not calculated. Consequently, a target of 150 interviews per stratum was set for a total of 450 interviews to allow for nonresponse and interviewer errors. However, only 318 interviews were collected across all three conditions: 100 from the Saginaw, 105 from the Kalamazoo and 113 from the Grand.

Communication with other researchers who had interviewed anglers during the summer of 1983 indicated that

1 to 3 interviews per hour could be performed. It became clear during pretesting of the questionnaire that the collection of interviews would sometimes be lower than this rate. An additional interviewer was employed to insure an adequate rate of interviewing during the interviewing period between July 1st and Labor Day, 1984.

Limitations

The sample sites for this study were deliberately located to ensure that anglers of all socioeconomic levels would have equal access to the study sites. However, anglers who exclusively used private marinas were excluded from the sample population.

Also, anglers who used remote fishing locations and not heavily used public access sites were not included. In addition, anglers who exclusively use fishing sites outside of the study area were not included. Rural anglers, as well, (i.e. those who fish more than 50 miles from the urban centers of the study) were not likely to be included in the survey population.

Credibility of Small Samples

Sudman (1976) uses a subjective scale that gives an indication of the credibility of a small sample study. In creating the sampling plan extensive use was made of the scale. Due to limitations in time and money not all the criteria were optimized, but an effort was made to address them all. What follows is a brief discussion of each of these criteria and the sample plan used for this study.

Three criteria are mentioned by Sudman (1976) as important to generalizability. The first deals with geographic spread. It was not possible to address the entire angler population of Michigan nor even the entire angler population of the Lower Peninsula. However, it was possible to have study sites that represented different geographic locations in the lower half of the Lower Peninsula. In addition, care was taken so that surveys were collected from more than one location on each river.

The second criterion deals with a discussion of the limitations of the sample. This has been outlined above and was recognized before the study began.

The third criterion deals with the use of special populations. Only the population of interest should be included in the sampling plan. This meant that it is not efficient, nor desirable to survey people who do not properly belong in the population of interest. In this study only those anglers who were confronted by contaminated conditions were included in the sample population. Since this was also the target population, the sampling scheme was very efficient.

Three other areas of concern are also mentioned by Sudman: sample size, sample execution and use of resources, such as time, money and personnel. Sample size has already been discussed. Sample execution deals with the actual collection of the data and the quality of that collection process. The response rate of 318 out of 338 contacts suggests the sampling was executed properly. The use of resources is very subjective. If a list of anglers who met the criteria of the study had been available efficiency could have been improved by minimizing the sampling cost per response.

Analysis

To measure the perceptions of toxic chemicals by anglers a previously constructed scale was sought. Because of the scarcity of work in this area no such scale was available in the literature. To measure these perceptions three subscales were created relating to the presence of toxic chemicals in the waters being fished, the presence of toxic chemicals in the fish in the waters being fished and the threat to health from toxic chemicals.

In accordance with the concept that it is necessary to first perceive that a hazard is present before it elicits a response, a series of items were created that fell into one of the above three categories. It was decided to use a six point forced choice response set to eliminate the problem of the undefinable middle point and also to gain impressions from respondents who might otherwise feel unqualified to respond to the items. The procedures used to calculate reliability were taken from Nunnally (1978).

The scale, along with other items in the questionnaire were pretested during June, 1984. The initial reliability coefficients for each of the subscales were: .73 for the subscale pertaining to toxic chemicals in the water; .63 for the subscale pertaining to toxic chemicals in the fish; .56 for the subscale pertaining to threats to health; and .79 when the three subscales were combined.

The low reliability coefficient of the fish and health subscales resulted in the addition of more items to those subscales to increase the reliability. However, the additional items led to reliability coefficients lower than those already obtained. The results of these additions were unproductive and a decision was made to use the scales as they were with the expectation that an increased sample size would lead to an improved reliability coefficient. The final reliability coefficients are found in the Results section. The final items used in this scale can be found in Appendix B.

Other items used were constructed following procedures common to survey design and can be found in Appendix C attached to this document.

Limitations of a Likert-type Scale

A Likert-type multi-item scale is one of the least sophisticated of many types of ordinal scales available. With a possible range of scores of only one to six, the standard deviation found within groups has to be very small to allow any significant differences to be found. Alternative methods, such as rank-orderings or paired comparisons (Nunnally, 1978, p. 46), generally allow more precise measurements. In addition, these scales may be quantified with further mathematical manipulations.

The justification for using a Likert-type scale is that it gives respondents a task that is easier and more common than that of paired comparisons or rank-orderings. Further, when high levels of precision are not required, such as in this study, a Likert-type scale provides a relatively efficient means of making crude categorizations.

The use of parametric statistics on such a scale violates the general assumption of the data being gathered on an interval or ratio level of measurement. However, parametric statistics are often used anyways as a means of exploring relationships that might not otherwise be possible using the available nonparametric statistics. When this is done, it is assumed that the underlying distribution of the scale scores used is normal. Care should be taken to state the level of measurement used so that readers may decide for themselves the validity of such an analysis.

Statistics

The statistical procedure used in analyzing the data included: multiple regression, one-way analyses of variances, t-tests and chi-squares. The level of measurement and sampling procedures conformed to the basic assumptions of the statistical tests employed.

The t-test was used with data that was measured on an interval scale or higher. Age, income and education were all measured in this fashion. The chi-square test was used when two variables, measured on a nominal scale were compared to a variable measured on an interval or higher scale.

The One-Way Analysis of Variance was used between groups measured on an ordinal scale to take advantage of the highest powered statistical test available. In this case, the use of a parametric ANOVA was more likely to show any differences between groups, if any, than a nonparametric ANOVA. If the parametric ANOVA showed significant differences the test would be replicated using a nonparametric Kruskal-Wallis ANOVA.

A discussion by Blalock (1979) carries this issue a bit further. A Kruskal-Wallis ANOVA is considered by Blalock (1979) to have a power efficiency of ninety-five percent compared to a parametric ANOVA when large samples are used (p. 367). "If we refer to the power efficiency of one of these non-parametric tests as 95 percent, we mean that the power of the non-parametric test using 100 cases is approximately the same as that of the t-test using 95 cases if the model used in the t test is correct" (Blalock, 1979,

p. 253).

The power of a test is the probability that the test will show significant differences when those differences actually exist. By definition, a less powerful test is more likely to have a type II error: not showing significant differences when significant differences actually exist. Using a more powerful test, again by definition, means that one is less likely to make a type II error. Using the more powerful parametric ANOVA means that one is minimizing the chance of a type II error at the risk of violating the assumption of a known underlying distribution. However, with large groups, such as in this study, the assumption of normality is generally relaxed as the data will approach normality as the sample gets larger (Blalock, 1979, p. 253). This study, as already stated, made use of the more powerful parametric statistics.

Multiple regression was used in a secondary analysis of selected demographic variables. Multiple regression was used in this analysis due to a lack of a parallel test using nonparametric statistics. Again, the large sample size meant that the distribution of the data approached normality and the general robustness of the multiple regression analysis to violations of many assumptions made the test appropriate (Blalock, 1979, p. 387). The analysis included a check for multicollinearity, nonlinearity, residual outlyers and normality of the residual distribution.

Operationalization of the Hypotheses

Hypothesis 1:

Anglers will perceive real differences in the level of toxic chemicals present in their fishing environments when real differences exist.

The scale developed to measure the perception of toxic chemicals has been discussed above. This scale acts as an indicator of the level of perceived toxic chemicals present in the waters studied.

The real differences in the level of toxic chemicals present are represented by the three levels of warning published by the MDNR: all fish are unsafe to eat; certain fish are unsafe to eat, should not be consumed by high risk groups and/or should not be consumed in large quantities; no warning exists about the presence of toxic chemicals at this time (MDNR, 1984a).

The resultant operationalized hypothesis is: The perceived level of toxic chemicals, as indicated by the scale scores, will be significantly different between, and will correspond with, the three different conditions of toxic chemical contamination.

Hypothesis 2:

For those who perceive the presence of toxic chemicals, as the real level of toxic chemicals contamination increases the number of anglers who consume the fish they catch will decrease.

The three levels of toxic chemical contamination have been discussed above.

Those anglers who do not consume the fish they catch are considered to be participating in an avoidance behavior. Figure 1 shows this as one of the choices in the decision tree. A precondition of being able to make this choice is also present in Figure 1: anglers need to have determined that toxic chemicals are present before this choice occurs. Anglers who do not perceive the hazard as being present are assumed to not be responding to the threat posed by toxic chemicals.

This precondition is measured using the scale described above. Recall that the scale is a six point Likert-type scale. The midpoint of the six point scale is 3.5. Any score above this midpoint indicates at least some agreement that toxic chemicals are present. Any score which falls below this midpoint indicates at least some disagreement that toxic chemicals are present.

For this hypothesis only those anglers who have average scores above 3.5 are considered in the analysis. These anglers are considered to at least slightly agree that toxic chemicals are present on the sites they are fishing.

This criterion is followed across all three study conditions including the condition where there is no warning about the presence of toxic chemicals. Swartz and Strand

(1981) looked at the effect of misinformation on behavioral responses to a hazard. They found that the perception of a hazardous situation, even though false, could lead to significant behavioral changes. Those anglers who "perceive" the presence of toxic chemicals where those chemicals are not present would be expected to behave in the same way as if toxic chemicals really were present.

The operationalization of this hypothesis is that the number of anglers who avoid toxic chemicals by not eating the fish they catch will be significantly and positively correlated with the real level of toxic chemicals present.

Hypothesis 3

For those who perceive the presence of toxic chemicals, as the real level of toxic chemicals increases so will the number of anglers who participate in coping behaviors.

Again the conditions of the study relating to the levels of toxic chemicals has been discussed extensively.

The precondition that anglers need to be able to perceive the presence of toxic chemicals before they can respond to their presence is the same as for Hypothesis 2. The precondition is measured in the same way as for Hypothesis 2.

Figure 1 illustrates two types of coping behaviors that are used in this study. These two types of coping behaviors are: alternative preparation procedures of the fish caught and alternative cooking procedures. Alternative preparation procedures were indicated by asking anglers how they prepared the fish they caught. This question was asked before toxic chemicals were mentioned. Those anglers who responded that they skinned, cut off excess fat or filleted the fish they caught were considered as making an effort to cope with the presence of toxic chemicals in the fish they caught. These procedures paralleled those recommended in the Michigan Fishing Guide (MDNR, 1984a). Alternative cooking procedures were defined as baking, broiling or smoking the fish caught.

An angler who participated in any one of these alternative procedures was considered as coping with the presence of toxic chemicals in the fish caught. Coping, for this study, is defined as a behavior to reduce the risk of toxic chemicals while not avoiding the risk entirely. Alternative preparation and cooking procedures reduce the risk, but they are not as effective as not eating those fish.

The operationalization of this hypothesis is: The number of anglers who participate in alternative preparation and cooking procedures of the fish they catch is significantly and positively correlated with the real levels of toxic chemicals present in the areas being fished.

Hypothesis 4

Anglers who have had negative experiences with consuming fish contaminated by toxic chemicals in the past will participate in coping behaviors at a higher rate than anglers who have not had such experiences. Coping behaviors are measured in the same way as described for Hypothesis 3.

To indicate past negative experiences with toxic chemicals anglers were asked if they, or anyone they knew, had been made sick from fish they believed were contaminated by toxic chemicals during the last year. Those who answered that they had had such an experience were considered as the group with negative experiences from toxic chemicals. All other anglers formed the no negative experience group.

The operationalization of this hypothesis is: Anglers who have been made sick from fish they believed were contaminated by toxic chemicals, or knew someone who had been made sick during that same time period, will participate in coping behaviors at a significantly higher rate than anglers who have not had such negative experiences.

Hypothesis 5

Anglers of high socioeconomic status will be more accurate in their perceptions of toxic chemicals than anglers of low socioeconomic status.

Accuracy in perception was measured making the following assumptions about the toxic chemical perception scale: Anglers who fished under the two conditions where toxic chemicals were present were considered accurate in their perceptions if their averaged scale scores were greater than the midpoint value of 3.5. Anglers who fished under the condition where no toxic chemicals were present were considered accurate if their averaged scale scores were less than the midpoint value of 3.5.

Anglers who agree to any extent that toxic chemicals were present when toxic chemicals were indeed present and disagreed to any degree when toxic chemicals were not present were considered as accurate in their perceptions. Anglers who do not meet this criteria were considered inaccurate in their perceptions. Age, income and education were used as indicators of socioeconomic status.

The operationalization of this hypothesis is: Age, income and/or education will be significantly higher for anglers who are accurate in their perceptions of toxic chemicals than for anglers who are inaccurate in their perceptions of toxic chemicals.

RESULTS

The overall research paradigm for this study is summarized in Figure 1 in the Introduction. This model is divided into two major parts: the perception of toxic chemicals and the behavioral responses to the presence of toxic chemicals.

The study was designed to determine if toxic chemicals in waters fished by anglers exceed the "threshold of awareness" mentioned by Burton et al. (1978) where toxic chemicals actually exist. When toxic chemicals are perceived to be present, this study looks at how anglers respond to the perceived presence. Lastly, two mediating variables, past experiences with toxic chemicals and socio-economic status, are examined to determine if they are associated with behavioral responses to toxic chemicals.

Reliability of Perception Scale

Perception of toxic chemicals is measured by a scale constructed specifically for this study. This scale is composed of nine items shown in Appendix B. These nine items had a reliability coefficient of .91 with inter-item correlations ranging from .35 to .75.

This scale was formed by combining two subscales. One was composed of five items that asked about the presence of toxic chemicals in the waters being fished. This subscale had a reliability coefficient of .83 with inter-item correlations ranging from .35 to .65.

The other subscale was composed of four items that asked about the presence of toxic chemicals in the fish. This subscale had a reliability coefficient of .80 with inter-item correlations ranging from .41 to .75.

In addition to the above two subscales another subscale composed of four items was created. This subscale had four items and asked questions that dealt with the perceived threat to health from toxic chemicals. The reliability coefficient for this subscale was .50 with inter-item correlations ranging from .07 to .46. Because of the low reliability of this subscale it was not used in the analysis of the data.

According to Nunnally (1978, pp. 245-246) an acceptable reliability coefficient for studies where great precision is not required would be about .70. The scale used for the analysis of the data exceeded this minimal level of reliability.

Control for Environmental Conditions

In selecting study sites, it was impossible to control for all details of the environment where respondents were located. To provide some estimate of equivalency across the study sites several ten-point questions were asked of respondents pertaining to the surrounding land area and the waters being fished.

The characteristics for the surrounding land areas were: beautifulness, naturalness and cleanliness. The characteristics for the waters being fished were: clarity, cleanliness, fragrancy, freshness and overall water quality.

The only characteristic that was significantly different across the three conditions of the study was the beauty of the surrounding land area (Table 1).

Hypothesis 1

Anglers will perceive real differences in the level of toxic chemicals present in their fishing environments when real differences exist.

Anglers were asked to give their degree of agreement with nine items concerning the presence of toxic chemicals in the waters and in the fish. It was expected that anglers would show the greatest degree of agreement that toxic chemicals were present at the most contaminated site, the least at the noncontaminated site and some intermediary level of agreement for the moderately contaminated site.

In Table 2 a six would indicate strong agreement that toxic chemicals were present in the fish and water. A one would indicate strong disagreement that toxic chemicals were present.

In this study, there were no significant differences in the perceived levels of toxic chemicals across the three conditions. The null hypothesis cannot be rejected.

Table 1

<u>Rating of the Beauty of the Surrounding Land Across the Three Study Conditions</u>

	Grand River (No contamination)	Kalamazoo River (Medium)	Saginaw River (High)
mean	7.1	6.1	6.4
s.d.	1.9	2.2	2.3
N	111	105	100

Note: One-way ANOVA; df = 2, 313; F = 6.978; alpha = .0011

*
1 - The surrounding land area is ugly
10 - The surrounding land area is beautiful

Table 2

Toxic Chemical Perception Scale Scores Across Three Levels of Toxic Chemical Contamination*

	Grand River (No contamination)	Kalamazoo River (Medium)	Saginaw River (High)
mean	3.8	4.2	4.1
s.d.	1.2	1.2	1.4
N	100	95	93

Note: One-Way ANOVA; df = 2, 285; F = 1.85; alpha = N.S.

* 6 - strongly agree that toxic chemicals are present
1 - strongly disagree that toxic chemicals are present

Hypothesis 2

For those who perceive the presence of toxic chemicals, as the real level of toxic chemical contamination increases the number of anglers who consume the fish they catch will decrease.

Two types of avoidance behavior were identified for this study: avoidance of the fishing location and avoidance of fish containing toxic chemicals by not consuming those fish. Since this study took place on-site, those people who avoided fishing at those locations were not part of the sample population.

However, the threat from toxic chemicals in fish can be avoided by not eating those fish. An angler can still participate in fishing and, if the fish are not consumed, that angler can avoid the threat posed by contaminated fish.

This hypothesis also presupposes that anglers can perceive the presence of toxic chemicals. Only those anglers who indicated at least some agreement that toxic chemicals were present were included in this analysis.

Table 3 summarizes these results. The chi-square for this analysis is nearly significant at the .05 level. The trend depicted in Table 3, however, is not in the predicted direction. The null hypothesis cannot be rejected.

Hypothesis 3

For those who perceive the presence of toxic chemicals, as the real level of toxic chemicals increases so will the

Table 3

Planned Consumption of Fish Versus Location
(Percentages in parentheses)

	Grand River	Kalamazoo River	Saginaw River	Row Totals
Plan to eat fish caught	28 (49.1)	38 (66.7)	26 (45.6)	92 (53.8)
Do not plan to eat fish caught	29 (50.9)	19 (33.3)	31 (54.4)	79 (46.2)
Column Totals	57 (33.33)	57 (33.33)	57 (33.33)	171 (100.0)

Note: Chi-square = 5.83; df = 2; alpha = .054

number of anglers who participate in coping behaviors.

The rationale for this hypothesis is the same as for hypothesis 3. It was expected that anglers would participate in coping behaviors in greater numbers when the real level of toxic chemicals was greatest. Coping behaviors were indicated in this study by those anglers who participated in any one of several alternative methods of fish preparation or cooking.

Again, it was a precondition for inclusion in the analysis that anglers perceived the presence of toxic chemicals in the waters they were fishing and/or the fish in those waters.

Table 4 summarizes these results. The chi-square for this relationship is highly significant, but the trend is in the opposite direction as that predicted. Anglers at the most highly contaminated condition participate in coping behaviors at a lesser rate than anglers in either of the other two conditions. The null hypothesis cannot be rejected.

Hypothesis 4

Anglers who have had negative experiences with consuming fish contaminated by toxic chemicals in the past will participate in some form of coping behavior at a higher rate than anglers who have not had such experiences.

Past experiences with natural hazards has been shown to lead to an increase in coping behaviors in some studies.

Table 4

Coping Behavior Versus Location
(Percentages in parentheses)

	Grand River	Kalamazoo River	Saginaw River	Row Totals
Cope with toxic chemicals	38 (60.3)	45 (66.2)	24 (38.7)	107 (55.4)
Do not cope with toxic chemicals	25 (39.7)	23 (33.8)	38 (61.3)	86 (44.6)
Column Totals	63 (32.6)	68 (35.3)	62 (32.1)	193 (100.0)

Note: Chi-square = 10.80; df = 2; alpha = .0045

The hazard in this study is fish containing toxic chemicals. It was expected that past negative experience(s) with such fish would lead to an increase in the number of coping behaviors by anglers.

Past experience with the negative effects of fish contaminated by toxic chemicals was indicated by asking anglers if they or anyone they knew had been made sick from fish they believed were contaminated by toxic chemicals during the past year. Coping behaviors were to be indicated in the same fashion as represented in Hypothesis 3.

The number of anglers who said that they had had such negative experiences was extremely low. Only 14 of the 312 anglers said they or someone they knew had been made sick from fish they believed were contaminated by toxic chemicals. The average number of instances of these experiences for these 14 people was 1.2. Any further analysis of this data, because of the low response, would be misleading.

Hypothesis 5

Anglers of high socioeconomic status will be more accurate in their perceptions of toxic chemicals than anglers of low socioeconomic status. Age, income and education were used as indicators of socioeconomic status.

Accuracy in the perception of toxic chemicals was indicated by using the toxic chemical perception scale scores. Anglers were judged "accurate" when their scale scores showed at least some agreement with the actual conditions that existed at each of the study sites. Anglers were divided into two groups: those whose perceptions were accurate and those whose perceptions were not accurate.

A t-test was run for each of the socioeconomic status indicators as each was measured using a ratio scale of measurement between accurate and inaccurate anglers to determine if there were any significant differences.

Table 5 summarizes the results of this analysis. None of the socioeconomic status indicators was significantly different between the two types of anglers. The null hypothesis was not rejected.

<u>Survey Population Versus a Larger Scale Study</u>

The Fisheries Division of the Michigan Department of Natural Resources in cooperation with the Park and Recreation Resources Department at Michigan State University is conducting a large-scale study of anglers across the state of Michigan (Mahoney, Jester and Kikuchi, in preparation). The sample size for that study is 5155 and is composed of all anglers who purchase fishing licenses in Michigan. The preliminary results from that study are presented here to provide a comparison between the two survey populations.

To differentiate between the two studies, the study being done by the Fisheries Division will be referred to as

Table 5

Accurate Versus Inaccurate Perception Groups on Age, Education and Income

Variable	Group (means) Accurate	Inaccurate	t-value	probability
Age[1]	38.4	39.9	-.88	.19
s.d.	14.6	14.4		
N	168	119		
Education[2]	11.8	11.5	1.0	.15
s.d.	2.7	3.1		
N	167	120		
Income[3]	29.6	22.6	1.1	.13
s.d.	61.6	15.6		
N	153	106		

1 - in years
2 - in years
3 - in $thousands

the MDNR study. The results of the sampling from the study done for this dissertation will be referred to as the on-site study.

In the MDNR study 94.5% of respondents were male. In the on-site study 84.6% of respondents were male. The practice of allowing spouses to fish off one license may help explain the high number of males in the MDNR study; presumably males are the primary purchasers of licenses.

The overall mean of the age of respondents in the MDNR study was 43.6 with a median of 40.9. In this study the age mean was 39.5 with a median of 35.9. Teenagers sixteen or over were eligible to participate in the on-site study. Part of the difference may be due to the inclusion of a small number of anglers who were under eighteen. These anglers are not required to purchase fishing licenses and would not be part of the MDNR survey population.

In the MDNR study 81.5% of the respondents were white, 2.2% were black with 16.3% being of some other race or were part of the missing value set. In the on-site study 61.3% were white, 32.4% were black, 4.4% hispanic, 1.6% oriental and .3% of some other race. Since the rivers chosen for this study were close to urban centers the high representation of minorities may be partially explained by this factor.

In the MDNR study, education was measured using a nominal coding scheme that is not directly comparable to the on-site study. Of those who responded to the question, 53.9% had at least a high school diploma. The median for the on-site study was 11.9 years of education which would be indicative of an education level just slightly less than the MDNR study.

In the MDNR study the median of annual family income was approximately $24,922. In the on-site study the median was $19,013. If poor people are less inclined to purchase fishing licenses, then that propensity might explain the difference between the two survey populations.

The differences encountered between the two sample populations may be accounted for by the differences in sampling methods and the types of sites sampled. If minorities and/or poor people are less likely to purchase fishing licenses then the sample from this study is probably more representative of anglers found at rivers near urban centers than the MDNR study.

Internal Profile of the Survey Population

To give an overall perspective on the entire survey population and the three subpopulations, a brief summary of some demographics is presented at this point. Because most of that information is repetitive it will presented primarily in tabular form.

The first variable shown, miles of home from the sample site indicates that anglers travelled a greater distance to reach the Kalamazoo study sites than the other two study sites (Table 6). This is most probably due to the study sites on the Kalamazoo being located at a greater distance from the selected urban centers than the Saginaw or Grand river study sites.

Table 7 shows that the proportion of males to females was consistent across the study conditions. Age also, shown in Table 8, was approximately the same across the study conditions.

Table 9 indicates that there was a greater representation of minorities on the Saginaw than on either of the other conditions. Tables 10 and 11 indicate that education and income levels were lowest on the Saginaw when compared to the other two conditions.

Description of Angler Behavior Towards Toxic Chemicals

Several variables were included in the study that were not part of the hypotheses of the study. Selected variables are included herein for their value in furthering understanding of the population sampled.

The variables which will be described include: familiarity with toxic chemicals; knowledge about detecting the presence of toxic chemicals; knowledge about where to find out about toxic chemicals; and the numbers of anglers who read the warning on the MDNR brochure.

Table 6

Distance Anglers Travelled to Reach Study Sites
(in miles)

	Grand River (No contamination)	Kalamazoo River (Medium)	Saginaw River (High)
median	4.2	24.9	6.2
mean	41.0	57.7	24.0
s.d.	233.8	118.9	77.3
N	111	105	100

Table 7

Sex of Anglers Across Study Conditions

	Grand River	Kalamazoo River	Saginaw River
males	83%	86%	85%
females	17%	14%	15%
N	112	106	100

Table 8

Age of Anglers Across Study Conditions

	Grand River	Kalamazoo River	Saginaw River
median	34.5	36.7	36.2
mean	37.9	39.8	41.1
s.d.	13.3	14.2	16.1
N	110	106	100

Table 9

Race of Anglers Across Study Conditions

	Grand River	Kalamazoo River	Saginaw River
Black	21.4%	25.5%	52.0%
Hispanic	3.0%	4.7%	6.0%
Oriental	1.6%	0.0%	1.0%
White	71.3%	69.8%	41.0%
Other	.3%	0.0%	0.0%
N	112	106	100

Table 10

Education Levels Across Study Conditions

	Grand River	Kalamazoo River	Saginaw River
median	12.1	11.9	11.7
mean	12.5	11.6	10.9
s.d.	2.7	2.8	3.4
N	110	105	100

Table 11

Annual Family Income Across Study Conditions
(in $thousands)

	Grand River	Kalamazoo River	Saginaw River
median	22.0	20.0	15.9
N	101	101	83

Table 12 indicates that anglers were generally unfamiliar with toxic chemicals, but there were no differences across the three study conditions.

The single greatest response when anglers were asked how they would detect the presence of toxic chemicals in the environment was "don't know". The second most popular response was "would get sick". Table 13 summarizes these results across sites.

When asked where they would seek information about toxic chemicals if they wanted to know more, almost half the anglers indicated they would seek such information from the Michigan Department of Natural Resources. A substantial number said they did not know. And a smaller percentage mentioned the Public Health Department. These results are summarized in Table 14.

Lastly, anglers were asked if they had read the MDNR brochure. Of those who responded to this question, about half the anglers said no or that they did not get one and about ten percent said that they had read the brochure. Table 15 gives these results.

<u>Secondary Analysis</u>

As a result of the initial inspection of the results, an additional analysis of the data was prepared. This additional analysis consisted of a multiple regression of the perception scale scores on the variables of age, income, education and miles of angler from home.

Table 12

Familiarity with Toxic Chemicals Across Study Conditions*

	Grand River	Kalamazoo River	Saginaw River
mean	2.5	2.4	2.4
s.d.	.9	.9	1.0
N	109	105	97

* 5 = extremely familiar; 1 = not at all familiar

Table 13

How Anglers Detect the Presence of Toxic Chemicals

	Grand River	Kalamazoo	Saginaw	Total
Mentioned most often	Don't Know (24.1%)	Don't Know (26.7%)	Don't Know (23.5%)	Don't Know (24.7%)
Second most mentioned	Dead Fish (10.2%)	MDNR Tests Appearance of water (6.7%)	Get Sick (13.3%)	Get Sick (8.7%)
N	108	105	98	311

Table 14

Where Anglers Find Out About Toxic Chemicals

	Grand River	Kalamazoo	Saginaw	Total
Mentioned most often	MDNR (46.8%)	MDNR (50.5%)	MDNR (48.5%)	MDNR (48.6%)
Second most mentioned	Public Health (11.9%)	Don't Know (13.3%)	Don't Know (21.6%)	Don't Know (14.8%)
Third most mentioned	Universities (12.4%)	Universities (5.7%)	Public Health Library (6.2%)	Public Health (7.7%)
N	109	105	97	311

Table 15

Anglers Who Read MDNR Brochure Across Study Conditions

	Grand	Kalamazoo	Saginaw	Total
Read brochure	54.1%	49.5%	45.9%	50.0%
Did not read brochure	34.9%	38.1%	42.9%	38.5%
Did not receive brochure	10.1%	11.4%	10.2%	10.5%
Don't Know	.9%	1.0%	1.0%	1.0%
N	109	105	98	312

The above variables were chosen to determine if identifiable personal characteristics might benefit in predicting the perception of toxic chemicals. Such predictions would enhance management efforts as groups of people could be targeted for maximum management focus.

An unforced stepwise multiple regression was run to determine the optimal linear solution. Scatterplots were done for each of the independent variables and the perception scale scores to insure that those relationships were not curvilinear. The results of these scatterplots did not give any indication of such a curvilinear relationship.

A basic assumption of regression models is "... that the random error terms are either uncorrelated random variables or independent normal random variables" (Neter and Wasserman, 1974). Two tests were run to check this assumption. The first consisted of a scatterplot of the residuals. Less than three percent of the residuals were more than two standard deviations away from the mean and none were greater than three standard deviations away from the mean. In addition, no regular pattern, such as a sine wave or skewness, showed up in the scatterplot. Pictorially the distribution of the residuals appeared random and in compliance with this basic assumption.

To further check for autocorrelation, a Durbin-Watson test was run and a value of 1.99 was obtained. The upper limit for the D statistic with n = 253 and the number of independent variables equalling four, is 1.74 for alpha equal to .05 (Neter and Wasserman, 1974, p. 816). This gives clear evidence that the residual terms were not significantly correlated.

Multicollinearity refers to the correlation of the independent variables in a regression equation with each other (Pedhazur, 1982, pp.232-244). If these correlations are very high they may lead to results which, though correct are meaningless. For example, when two independent variables are perfectly correlated, it can be shown that there are an infinite number of possible regression equations that perfectly fit the data (Neter and Wasserman, 1974, p. 340). There is, however, no present consensus as to what constitutes unacceptable intervariable correlation (Pedhazur, 1983).

Thus, an examination of a correlation matrix by a researcher may lead to inaccurate conclusions about the presence or nonpresence of multicollinearity. To counteract this problem, the results of this analysis were taken to a statistician for an objective evaluation. The results of that consultation were that no significant multicollinear effects were affecting the regression equation (Crabb, 1985). The range of simple correlations between the independent variables ranged from -.25 to .28. There were relationships between variables, but not enough to affect the outcome of the analysis (Crabb, 1985).

The actual stepwise regression analysis using the perception scale scores as the dependent variable and age, income, education and miles from home as the independent variables led to the inclusion of only three of those four variables: age, miles and income. The variable education did not contribute significantly to the overall explained variance. The resulting regression equation, using beta instead of B, was:

$$PSS = 4.87 - .25A - .17M + .15I$$

where PSS = Perception Scale Score
A = Age
M = Miles from home
I = Income

The multiple R for the equation was .34 with an R^2 value of .11. The variance accounted for by miles, age and income was small, but significant. A summary table of the results appears in Table 16.

Table 16

Summary of Stepwise Multiple Regression Analysis on Perception versus Age, Income, Education and Miles from Home

Variable*	R^2	Pearson's r	Beta	F**
Age	.06	-.25	.25	16.1
Miles	.09	-.18	.17	8.4
Income	.11	.14	.15	5.7
Education	.11	.12	.01	0.0

* - In order of inclusion into the stepwise equation.

** - F = 6.64 (df=1,infinite) alpha = .01
F = 4.60 (df=2,infinite) alpha = .01
F = 3.78 (df=3,infinite) alpha = .01
F = 3.32 (df=4,infinite) alpha = .01
(Blalock, 1979, p. 615)

DISCUSSION

The basic foundation of this study is the expectation of public agencies that the general public will use the economic rationality model in its decision making process. This led to a series of hypotheses, borrowed from the natural hazards literature, to determine if anglers indeed respond in a rational manner to the presence of toxic chemicals in the fishing environment. This section examines and attempts to explain the results of those hypotheses first looking at the issue of perception, then behavioral responses and lastly, mediating variables.

Perception of Toxic Chemicals

Mitchell (1974), when discussing the ability of people to detect several types of air pollutants, spoke of the need for these pollutants to be present in "chronic proportions" to be perceived. Apparently, in this study the presence of toxic chemicals did not reach chronic proportions. Anglers did not show any significant differences in perceptions of the levels of toxic chemicals across three levels of toxic chemical contamination.

If toxic chemicals are not perceived to be present, the choice process cannot begin (Burton et al., 1978). Figure 1 illustrates that anglers who do not perceive the presence of toxic chemicals would not be confronted with the need to choose from alternative responses to toxic chemicals.

The decision making framework and problems discovered

in the natural hazards literature is summarized in this quote from Sims and Baumann (1983):

> "By far the most prevalent and enduring logic determining policy in attempts to influence response to the threat of natural hazards is this: The provision of information on the hazard risk and education in proper mitigation measures will result in the public under threat being aware of both the nature of the risk and the wisdom of protective measures...It doesn't necessarily follow that because information is given it is received or because education is provided there is learning..." (p.187).

The results of this study do not support the contention that providing the public with correct information leads to the public being sensitive to the presence of toxic chemicals.

Recalling the economic rationality model described by Slovic et al (1974), one of the assumptions of that model is that people possess perfect information about the alternatives available to them and the consequences of choosing each of those alternatives. In a study pertaining to familiarity with local parks, Stynes et al (1985) found that people simply were not aware of all the parks available to them. Stynes et al (1985) suggest that other variables may be necessary to get at the complexity of how people become aware of parks. In a similar way, anglers in this study simply did not accurately perceive the presence of toxic chemicals even though information about those chemicals was available. Without an accurate assessment of the degree of threat present, anglers do not possess perfect information and the behavioral responses anticipated by management will occur only by chance.

Such findings suggest a change in management strategy. Lucas (1982) discusses the issue of "soft" and "hard" management regulations. As a rule the softest type of regulation that is effective is most appropriate. Too much regulation may be worse than no regulation at all.

However, the results of this study indicate that greater efforts may be needed to make the presence of toxic chemicals more "perceivable" to anglers. Such efforts as warning signs or some form of physical patrolling of hazardous sites might be appropriate. Radio or television advisories similar to those given for air pollution in big cities might be an innovative approach to heightening the perception of toxic chemicals. Informal discussion with anglers during the study hinted that warning signs were something they look for to help them determine the safety of a site.

The consequences of increasing regulations will surely lead to some impact on recreation experiences. As already discussed, leisure is <u>voluntary</u> in nature and <u>freedom</u> is a central aspect of the experience (Gunter, 1979). Increasing regulatory efforts will change the fishing experiences of anglers on affected rivers. Further research is needed to determine exactly what these impacts may be.

In addition, the lack of perception by anglers of the presence of toxic chemicals in the waters they are fishing points out a difference between "typical" natural hazards and toxic chemicals. "... toxic chemicals are not detectable by the human senses. Unlike floods, earthquakes, fires or tornados there are no physical signs or damage to aid in the identification of the hazard itself (Baum et al, 1983). People must rely on specialized measuring instruments or expert help to determine if toxic chemicals are present in their environment" (Udd and Fridgen, 1985).

An illustration of how people determine that undetectable hazards are present is presented by Barker (1970). In that study Barker found that over fifty percent of the people who participated in a study about water pollution in the Toronto area felt that they could determine if the water was polluted by using the sense of sight or smell.

In this study the most common response to a question about how anglers would detect the presence of toxic chemicals was "don't know" (Table 13). The second most common response was "would get sick" (Table 14). Neither answer suggests that anglers are well-informed about toxic chemicals.

In seeming contradiction, however, more than half of the anglers in this study said that they would seek information about toxic chemicals from either the MDNR or Michigan Public Health Department. Both of these sources would provide accurate information about the risk from toxic chemicals. Apparently, the threat from toxic chemicals is not perceived to be of sufficient magnitude for the anglers of this study to seek more information.

In contrast to most natural hazards, the effects of consuming toxic chemicals is of an uncertain magnitude and of an uncertain duration. This difference is one noted by Baum et al. (1983) between technological disasters and natural hazards. With the scientific community in doubt about the real threat from toxic chemicals, it cannot be expected that the public will be well-informed about this threat.

As already mentioned, there is considerable debate as to the degree of risk from toxic chemicals. Anglers may make the decision that the risk from toxic chemicals is too small to be of consequence to them. The risk that they perceive may be much lower than the actual threat defined by the MDNR. This would be consistent with the bounded rationality model discussed by Slovic et al. (1974). The differences in the decision making framework of the public and the MDNR expected decision making framework may help explain why anglers do not behave in the manner desired by the MDNR (Svenson and Fischhoff, 1985).

Anglers who would use an economic rationality model of decision making, as previously explained, would be expected to follow an optimal path that would minimize their risk from toxic chemicals. However, the lack of perception of the presence of toxic chemicals by anglers would preclude the decision making process from even occurring and would make the issue of which is the better model a moot point.

In summary, the differences in the levels of toxic chemicals present in this study were apparently not detected by anglers. This suggests that the provision of information about toxic chemicals has not brought the presence of toxic chemicals to the point of perceptability to anglers who continue to fish in contaminated rivers. Alternate management strategies may be necessary to raise the visibility of the hazard of toxic chemicals to anglers. Presently the perceived threat from contaminated fish appears too low for the anglers of this study to actively seek more information.

Behavioral Responses to Toxic Chemicals

Baker et al. (1980) conducted a study to determine the impact on visitation to a nearby beach from the potential construction of an offshore nuclear plant. Approximately 25 percent of the people they studied said they would avoid such a beach. However, when they examined actual behavior at a beach on a lake located near a nuclear plant they found actual avoidance was only 5 to 10 percent.

Anglers who avoided fishing on the rivers in this study due to toxic chemical contamination were not part of the

survey population. However, the anglers who were part of this study were asked if they would stop fishing at the study site if they knew toxic chemicals were present. Forty-eight percent of the anglers said they would avoid fishing if they knew toxic chemicals were present. If anglers in this study behaved in a manner proportional to the beachgoers in the study by Baker et al (1980), the actual avoidance behavior of anglers towards toxic contaminated waters would be expected to be from around 10 to 20 percent.

To estimate actual avoidance behavior, anglers in this study were asked if they had avoided fishing in waters they believed were contaminated by toxic chemicals during the past year. Twenty percent of the anglers in this study said that they had avoided such waters in the past. The three water areas most often mentioned were the Kalamazoo River (n=11), the Titabawassee River (7) and the Saginaw River (6). Each of these rivers did indeed have significant levels of toxic chemical contamination. The percentage of anglers who said that they would avoid waters contaminated by toxic chemicals is within the range expected from extrapolating from the Baker et al (1980) study.

Actual avoidance behavior towards toxic chemicals might have significant negative consequences on economies wholly or partially dependent on fishing revenues. Specific monetary losses to the economy have already been discussed (Swartz and Strand, 1981; Schulstad and Stoevener, 1978). A loss of 10 to 20 percent of anglers who might otherwise fish at a river cannot be ignored economically.

It should be noted that the rivers used in this study are far from being the most valuable sport fisheries in the state of Michigan. However, toxic chemicals are not limited to urban centers as noted in the Michigan Fishing Guide (MDNR, 1984a). The valuable Great Lakes sport fisheries also are contaminated by toxic chemicals. How this contamination is affecting the economies of the Great Lakes states is a question for future research.

Besides not fishing at a specific location, anglers can avoid the risk of consuming fish contaminated by toxic chemicals by not eating the fish they catch. This is also a unique characteristic of the hazard presented by toxic chemicals. "A few representative samples of natural hazards literature (Jackson, 1981; Hanson et al, 1979; Preston et al, 1983; Hansson et al, 1982; Evans and Jacobs, 1981), reveal that most of the subjects either live in the path of the potential hazard or the threat is a part of their everyday living environment (i.e. air pollution). With anglers, toxic chemicals in fish only become a threat when people enter a specific environment (where hazardous levels of toxic chemicals exist), participate in a specific recreation activity (fishing), and consume the fish they catch ..." (Udd and Fridgen, 1985, p. 2). Anglers have at their disposal a very simple means of protecting themselves from contaminated fish: don't eat the fish.

The relationship between the level of toxic chemicals and the consumption of fish was close to being significant (alpha = .0541). However, an examination of Table 3 shows that the relationship is not a linear one. Anglers who fish under the moderate toxic chemical contamination condition planned on consuming the fish they caught in greater numbers than the anglers under the high and no toxic chemical contamination conditions. Those anglers who were under the greatest threat from toxic chemicals consumed fish at approximately the same rate as those anglers under the no threat condition.

One possible explanation for such behavior might revolve around dissonance theory (Festinger, 1957). "With respect to both natural and manmade environmental hazards, there appears to be a pervasive tendency for inhabitants of high risk areas to: (1) deny the threatening aspects of their environments, and (2) markedly underestimate the probability of future disasters or calamities" (Shippee et al., 1980, p. 36).

The anglers in this study did not own the property from which they fished. However, the anglers who fished on the Kalamazoo made the greatest effort to reach their fishing locations based on the distance they travelled (see Table 6). Since these anglers came the greatest distance they also had the most effort invested in reaching the site they were fishing. Their denial might be based on the fact that they would not make such an effort to come to a fishing spot where the fish were not safe to eat.

It should be noted that the anglers in the above analysis were only those who reported at least some agreement that toxic chemicals were in the waters they were fishing. So, the analysis bypassed the problem of lack of perceiving the presence of toxic chemicals by selecting only those anglers who did have such perceptions. Nevertheless, such perceptions did not lead to reduced consumption:

> "So strong is the assumption of human rationality ... that many studies deal only with the causal link between the provision of information and heightened awareness, assuming that if that is achieved, behavioral change will inevitably follow...the evidence supporting the causal link between hazard awareness and protective responses is minimal..." (Sims and Baumann, 1983, p. 168).

To further examine the relationship between information and behavior, an analysis was done to determine if there was any relationship between having read the MDNR brochure and planned consumption behavior of fish contaminated by toxic chemicals. Having read the MDNR brochure was not related to the planned consumption of fish (chi-square = 1.08; df = 2; alpha = .58).

In addition to avoidance behavior, anglers may reduce the risk from toxic chemicals by using alternate preparation or cooking procedures. Such behavior parallels coping behaviors towards other natural hazards. For example, when confronted with the knowledge that a flood is imminent, people take precautionary behaviors to minimize their losses and danger to themselves and their families (Hansson et al, 1982).

The relationship between coping behaviors and the level of toxic chemical contamination was very strong (chi-square significant at .0045; Table 4). However, the direction of the relationship was in the opposite direction as that predicted. Anglers at the most contaminated site participated in coping behaviors at a lesser rate than anglers under the less contaminated conditions. The anglers in this analysis were only those who at least slightly agreed that toxic chemicals were present in the waters they were fishing.

When studying people's responses to the potential threat from earthquakes in San Francisco, Jackson (1981) suggests "... If earthquakes are among the most destructive of natural disasters, then a "rational model" would suggest that all people living in recognized zones of high seismic risk would be aware of the hazard, accept the possibility of damages and take all possible precautions to minimize the impact of future events. We have seen, however, that response to earthquake hazard shares none of these expected characteristics" (p. 408).

While toxic chemicals in fishing waters do not represent a threat of the magnitude of a major earthquake, a "rational model" would suggest that anglers would take some actions to reduce their risk. However, the evidence of this study suggests that this is not the case. Anglers not only do not limit their consumption when toxic chemicals are present, they appear, in this study, to participate in fewer precautionary behaviors at the most hazardous site.

Again, dissonance theory might be a useful area of future research. Anglers who knowingly consume contaminated fish at the most hazardous sites are experiencing the greatest degree of dissonance. They are exposing themselves to the greatest level of threat, yet they continue to consume the fish they catch. Denial and/or underestimating the threat as discussed by Shippee et al. (1980) would be consistent with the findings of this study. The result of this denial is that some anglers are exposing themselves to a risk identified by the Michigan Department of Public Health as a threat to human health (MDNR, 1984a).

The limitations of the survey population should be recalled at this point. The survey population did not include those anglers who have stopped fishing at contaminated sites. It may be that the anglers who continue to fish at contaminated locations are not representative of people who fish in general. Anglers in this study have lower incomes when compared to state anglers in general (see p. 72). Further, the distance travelled to the fishing sites is very short for most anglers in this study. These two findings suggest that the anglers of this study do not have as many fishing alternatives available to them as state anglers in general. They may be fishing on "substandard" sites simply because the option of going somewhere else is not available to them.

Alternatively, fishing for some of the anglers in this study may be a necessity rather than recreational. These anglers may be dependent upon fishing available sites, even though they are contaminated, to supplement their food supply. The necessity of this supplemental source of food may outweigh any potential risk from toxic chemicals. This necessity, in turn, reduces the voluntary nature of the experience that generally characterizes fishing experiences.

In any case, if the population of this study is a special case or representative of the angling population in general, some anglers are at risk from toxic chemicals. "... When a real hazard is perceived as being minimal or nonexistent, a much more intensive management program is required" (Jubenville, 1978, p. 150).

Mediating Variables

Past experience with natural hazards is sometimes a

variable that can predict behavioral responses of people confronted with a natural hazard. Mitchell (1974), in a discussion of natural hazards research, suggests that personal experience with a hazard may lead to more coping or precautionary behaviors against a similar recurrence.

Hanson et al. (1979) found that having endured a devastating tornado led to an increase in precautionary behaviors even over twenty years after the event. In another study, Hansson et al. (1982) found that people who had experienced floods in the past were more willing to pay increased taxes to help with flood prevention programs.

The range of findings in the literature that deals with the predictive value of past experience range from very strong relationships to no relationships at all (Sims and Baumann, 1983). No studies that explored this relationship for toxic chemicals and people were discovered.

The main finding of this study was that few anglers had ever experienced negative consequences from the consumption of fish contaminated by toxic chemicals. Only 14 of the 312 (< 5%) anglers who responded to this item reported that they themselves or someone they knew had been made sick from consuming fish that they believed were contaminated by toxic chemicals.

It can be concluded from these findings that negative consequences from the consumption of fish contaminated by toxic chemicals represents a rare event so far. Slovic et al (1974) discussed the difficulty people have in estimating the probability of a rare event. Given the very small probability of being made sick from fish contaminated by toxic chemicals it would not be expected that anglers will accurately assess the probable outcomes of choosing among the various alternatives available to them.

The small probability of having experienced toxic chemicals as a hazard corresponds to the probability of having experienced any particular natural hazard (Baum et al., 1983). However, the low numbers of anglers in this study who had experienced such an event made this variable of little value in predicting anglers' responses to toxic chemicals. This is in contrast to its value in helping predict responses to some other types of natural hazards (Sims and Baumann, 1983).

The last hypothesis of this study dealt with the question of whether anglers of greater age or higher socioeconomic status would be more accurate in their perception of toxic chemicals. Mitchell (1974), in a review of a series of studies on air pollution in British cities found that age and socioeconomic status were most closely correlated with awareness of air pollution.

This study divided anglers into two groups: those who were "correct" in their perceptions of toxic chemicals in the waters they were fishing and those who were "incorrect".

No significant differences were found when these two groups were compared on the basis of age, income or education.

This finding does not help in identifying those anglers who are able to accurately assess the level of toxic chemicals present in the waters they fish. More problematically, these findings do not help to identify those anglers who are inaccurate in their perceptions of toxic chemicals in the waters they are fishing.

Given the other results of this study, even those anglers who perceive the presence of toxic chemicals in the waters they are fishing do not necessarily respond in a manner to protect their own health. The problem goes beyond simply raising the level of awareness of anglers about toxic chemicals.

If awareness and the possession of correct information does not lead to anglers taking protective measures, other means of protection may be necessary. Not forbidding anglers from fishing on contaminated waters will lead to some anglers being exposed to health threats associated with toxic chemicals. However, such actions should not be taken without consideration of the potential impacts of those restrictions.

Because present knowledge about the extent of the threat from toxic chemicals in fish is unknown this may be a serious problem or only a relatively minor problem. Future research which identifies the real probabilities associated with consuming fish contaminated by toxic chemicals may provide a guide to what extent anglers need protection.

Lastly, the secondary analysis using multiple regression looked at the predictive powers of several demographic variables and found a weak, but significant relationship between the perception of toxic chemicals by anglers and age, income and distance travelled to reach the fishing site. For age and miles the relationship was negative. The older anglers were, the lower the level of toxic chemicals they reported. A possible explanation for this comes from informal discussion with the anglers. A common response was "I've been fishing here for twenty years and nothing has happened to me yet". The perceived probability of being injured by toxic chemicals is much less than the indisputable fact that the angler is still alive. The long time frame that typifies the effects of toxic chemicals undoubtably makes any eventual consequences even more remote. And, again, the scientific community has had tremendous difficulty tracing health problems back to the consumption of contaminated fish.

The distance travelled to the fishing site is also negatively correlated with the perceived level of toxic chemical contamination. Cognitive dissonance may play a role in the following scenario: the farther an angler travels to reach a fishing spot the greater the commitment of time and money. It is difficult to internally rationalize all that time and effort to reach a site that the angler believes is contaminated by toxic chemicals. One way to minimize this dissonance is to cognitively minimize the dissonance (Festinger, 1957). Minimizing the presence of toxic chemicals in the fishing environment would help rationalize why the angler continues to fish at a contaminated location.

Income, on the other hand, was positively correlated with the perception of toxic chemicals. This is similar to Mitchell's (1974) findings which suggest that high income people are more likely to be exposed to information sources. The vast volume of information about toxic chemical contamination may lead to high income individuals at least being suspicious of most surface water. Informal conversations with anglers led to statements that many people felt toxic chemicals were "everywhere" and just had to be in the water they were fishing since they were everywhere else. It may be that too much information in the media leads to stereotyping the presence of toxic chemicals by anglers.

CONCLUSIONS

Three levels of toxic chemical contamination were used to examine differences in anglers in this study. Anglers showed no differences in their perception of toxic chemicals across those three conditions. They also showed no differences in their behaviors to minimize the risk of consuming fish contaminated by toxic chemicals across those three conditions. If anything, fewer precautions were taken under the most hazardous condition than for the other two conditions. No strong predictive variables were found to help identify accurate versus inaccurate "perceivers" of toxic chemicals.

The expectation that the provision of correct information would lead to increases in awareness and to precautionary behaviors to reduce the risk from toxic chemicals was not supported by this study. The economic rationality model discussed by Slovic et al. (1974) and Kolers (1983) predicts choices based on accurate information. Thus it is assumed that providing people with accurate information will lead to predictable decision making.

The bounded rationality model, also discussed by Slovic et al. (1974) and Kolers (1983) suggests that people do not make decisions based on perfect information and that they will not always act in a manner that is predictable. Two examples from this study help support that position. The first comes from the inability of anglers to perceive the presence of toxic chemicals. The second comes from the lack of differences in behaviors between anglers who perceived the presence of toxic chemicals.

The implication of this study is that the information program instituted by the MDNR has not led to differences in perceptions or behaviors under conditions of three types of warnings about toxic chemical contamination. If the risk from toxic chemical contamination is considered serious enough, then new means of changing the behavior of anglers should be explored.

Before any new programs are implemented, however, economic analyses may be warranted to determine the impacts on the local and state economies. It may be that the return in added safety will not justify additional expenditures.

The problem becomes a balancing act between the economic concerns, the rights of anglers to fish where they choose and the possible health effects from not regulating fishing activity. All of these concerns cannot be maximized simultaneously. At the time of this study, the rights of anglers to fish where they choose is at a maximum. There are no legal restrictions to prevent them from fishing at sites which have hazardous amounts of toxic chemicals.

In summary, toxic chemicals in fish pose a health threat to anglers. The decision tree model adapted from

Svenson and Fischhoff (1985) and from the natural hazards literature provided structure for this research effort. However, anglers did not choose those behaviors which would minimize their risk from toxic chemicals in association with the degree of actual risk present. Further intervention may be necessary if the precautionary behaviors on sites contaminated by toxic chemicals are to be increased significantly.

Future Research Needs

Because of the limited nature of the survey population of this study, a broader based study is necessary. Such a study would determine whether the characteristics of the anglers in this study are typical of all anglers or only those of the sample population. If anglers in general do not participate in risk-reducing behaviors then broad changes in management strategies may be necessary. The implication of this study is that the simple provision of printed information in fishing regulations is not enough to significantly alter behavior.

To explain anglers' responses to toxic chemicals an examination and application of dissonance theory would appear to be promising. In spite of knowing that toxic chemicals are present in the water, anglers continue to consume contaminated fish. Why they persist in this behavior may be addressable through dissonance theory.

Smoking cessation studies might also prove productive in providing study models for studying the relationship between toxic chemicals and anglers. At present there are no known addicting qualities attributed to toxic chemicals, but the habit of fishing a particular site may be a greater attractant than the deterrent posed by toxic chemicals.

Communication networks deserve study as well as they may provide clues on how to increase the awareness of anglers about toxic chemicals. The deliverance of the information may have more credibility if it is delivered through already existing communication networks.

The risk taking literature in recreation generally revolves around the enhancement of an experience due to the presence of some known risks. Toxic chemicals do not seem to offer much in the manner of enhancing any kind of experience, but the principles involved in the risk taking literature might lead to a greater understanding about the relationship between toxic chemicals and anglers.

As discussed earlier, informal discussion with anglers suggested that some anglers felt toxic chemicals are literally everywhere and therefore cannot be avoided. The perceived control literature may lead to some understanding of why such an attitude would exist.

Perceived control relates to the concept of whether people feel they do or do not have personal control over their environment and the events that occur in their lives

(Rothbaum et al, 1982). Individuals who feel they have a great deal of control over their environment are said to have an <u>internal</u> locus of control. Those who feel they do not have a great deal of control are said to have an <u>external</u> locus of control (Spector, 1982).

Individuals who have an internal locus of control "... may actually seek situations in which control is possible" (Spector, 1982, p. 483). Therefore, a possible research question might be that one would expect to find more internal locus of control anglers at low toxic sites and fewer internal locus of control anglers at high toxic sites. This would follow because one would expect anglers with an internal locus of control to seek out safer environments while one would not expect the same from external locus of control anglers.

Another explanation of angler behavior may simply be that anglers "adapt" to the presence of toxic chemicals. Adaptation is one of the alternative behaviors suggested by Hewitt and Burton (1971) and may explain why even when people were aware of the presence of toxic chemicals they did not take any precautionary actions to minimize their risk. "Apparently, we can hear so much about a hazard that it no longer frightens us" (Bell et al, 1978, p.35). News of toxic waste dumps, spills, the Superfund, the expense of cleanup and the widespread nature of the problem is constantly in the news. Fewer precautionary behaviors due to an overabundance of information would have exactly the opposite effect as that desired by public agencies.

In addition to exploring different theoretical frameworks, research is also needed to provide more accurate estimates of the real threats posed by toxic chemicals in fish. The extent of the threat should serve as a guideline for the amount of managerial effort to reduce the risk to the public.

The impact of toxic chemicals on the recreation experiences of anglers also needs attention. The results of this study show that the behavior of anglers can potentially be modified by the presence of toxic chemicals (see pages 89-90). These behavioral modifications certainly change the fishing experience. Whether this effect is positive, negative or neutral is unknown.

Toxic chemicals may also affect other types of recreationists. For instance, boaters or swimmers may be adversely affected by the presence of toxic chemicals both physically and psychologically.

Lastly, there is a need to determine what is a reasonable balance between visitor safety, leisure freedom and economic consequences. All three variables interact and a change in any of the three can affect the other two.

Recommendations for Management of the Study Rivers

The MDNR is in a difficult situation. Any action or inaction will affect one of the variables mentioned in the triangle of variables above. Increasing management protection efforts may have spillover effects on uncontaminated rivers (witness the effects on uncontaminated shellfish in the study done by Swartz and Strand (1981)). More specifically, increased management protection will change fishing experiences and some anglers will be antagonized.

However, the situation on the Saginaw River should be of particular concern. All fish are considered unsafe to eat in any amount. Yet anglers are consuming fish at that site. At the very least, the MDNR should post notices at reasonable intervals along the Saginaw to increase the perceptability of the hazard to anglers.

Due to the possibility of vandalism of these signs, it may be necessary to occasionally send someone out in the field to warn anglers about the potential threat from toxic chemicals. Ideally, attractive alternatives could be identified where the fish are safe to eat.

However, because of the convenience of fishing on the Saginaw, stiff resistance should be expected. If the threat is discovered to be of sufficient magnitude it may be necessary to switch to hard management efforts that may carry the power of law on the Saginaw. Regardless of the method tried, some people will undoubtably continue to fish.

On the Kalamazoo the problem is not as severe because the warning is only for certain fish and for large consumption levels (> 26 pounds per year (MDNR, 1984a)). However, for some reason, anglers on the Kalamazoo are the most likely to consume the fish they catch even when they are aware that toxic chemicals are present. It was speculated that this might be due to their greater commitment to the sites studied. If this is the case then increased management efforts may be necessary to counteract this commitment.

Efforts similar to those taken on the Saginaw might be appropriate on the Kalamazoo. However, because of the more dispersed nature of fishing on the Kalamazoo such efforts would be more costly and difficult to implement. A higher dependence upon increased signing rather than increased patrols might be most efficient.

While the threat on the Kalamazoo is not considered to be great, the idea that commitment may lead to an increased liklihood of consumption needs further examination. Anglers who travel a great distance or who spend a great deal of money on fishing gear may be very committed to certain types of fishing at certain locations (Bryan, 1979). This commitment may act as a barrier to accepting regulations when toxic chemicals are discovered. This might be particularly true for more popular fishing areas in the northern part of the state and on the Great Lakes.

Lastly, the Grand River, where sampled, is considered to have no hazardous levels of toxic chemicals. Yet, the average scores on the perception scale for the Grand were not significantly different from those of the other two rivers. This implies that the Grand River is considered as contaminated as both the Kalamazoo and the Saginaw. Such beliefs may lead to unwanted avoidance behaviors. As mentioned, Swartz and Strand (1981) found that imperfect information may have the same consequences as correct information. Care must be taken that waters that are not contaminated are not confused with those waters which are contaminated. The image of more than just the affected river may suffer from the presence of toxic chemicals. Further research might explore the effects of toxic chemical contamination on the images of adjacent uncontaminated sites as well as effects on regional and statewide images.

In summary, the two decision making frameworks described early on in this study appear to be appropriate in helping understand the differences in how management would like anglers to behave and how anglers behave in reality. No solution is offered here to resolving the differences. However, the acknowledgement by management that people do not make predictable decisions might lead to more productive communication between managers of public lands and the public.

Lastly, toxic chemicals pose a threat to the health of anglers. The fact that this threat occurs in a recreation setting does not diminish the threat. Further, with continual improvements in our measuring techniques, toxic chemicals will be discovered in more and more recreation environments. The true scope of the problem is only now being discovered.

On one hand, the quality of life is degenerating and on the other, the threat to life is increasing. At some point, the trends must be reversed. Managerial actions to protect people from hazards created by people are only patchwork efforts. Until people stop creating the hazards, there is no far-reaching solution.

APPENDICES

APPENDIX A

Sampling Locations

Samping Locations
(Summer, 1985)

River	Location
Saginaw	Veteran's Park, Saginaw County, between Saginaw and Bay City
Saginaw	East riverfront park areas extending from south of downtown to city limits, city of Saginaw
Kalamazoo	Morrow Pond, Public Access Site, between Galesburg and Comstock, Kalamazoo County
Kalamazoo	Allegan Dam, west end of Allegan Lake, Allegan County
Kalamazoo	North and south of bridge, New Richmond, Allegan County
Kalamazoo	Hacklander Public Access Site, 2 miles east of Douglas, Allegan County
Kalamazoo	Schultz Park, City of Douglas
Grand	Francis Park, riverfront area and boat launch on opposite side of river, City of Lansing
Grand	Riverfront Park, City of Grand Rapids

APPENDIX B

Perception Scale Items

Perception Scale Items*

The **WATER** area I am fishing in now contains toxic chemicals.

The **FISH** in the water I am fishing in now contain toxic chemicals.

The **WATER** I am fishing in now contains dangerous levels of at least one toxic chemical.

It is highly unlikely that the **FISH** in the water I am fishing contain any toxic chemicals.

Compared to other water areas I fish, the level of toxic chemicals in this **WATER** area is low.

The **FISH** in the water area I am fishing in now contain dangerous levels of toxic chemicals.

Toxic chemicals are **not** present in this **WATER**.

Compared to other water areas I fish the level of toxic chemicals in the **FISH** in this water area is low.

There are large amounts of toxic chemicals present in this **WATER**.

* Responses ranged from strongly agree to strongly disagree on a six point scale.

APPENDIX C

Questionnaire

WEATHER ________________ DATE ____________________

ANGLER TYPE ____________ LOCATION ________________

TIME ___________________ RIVER BANK ______________

BOAT ____________________

1984
ANGLER STUDY
Michigan State University
Park and Recreation Resources
FINAL VERSION

Excuse me. I'm from Michigan State University and I'm doing a study on the perception of Michigan waterways by anglers. Can I take a few minutes of your time to ask you some questions?..... Thank you! First of all I need to tell you that I'm from the Park and Recreation Resources department at Michigan State. If you have any questions or concerns about what we're asking please feel free to call the department. Also, any information I collect will be kept completely confidential. That means that we will use the data we collect as a group, but we won't be publishing any one's questionnaire by itself. There will be no way that anyone will be able to find out what you answered on the questionnaire.

First we need some information about you as an angler.

1) When you fish, do you usually fish for a specific type of fish?

_____ yes _____ no

If yes, can you tell me what species of fish?

____

2) What type of fish would you **most** like to catch today? [NEED ONE TYPE OF FISH HERE FOR THE ANSWER

____

3) How many days each year do you fish?

____

4) How many days each year do you fish **at this site.**

____

5) Could you tell me how important it is to you to catch a fish today?

extremely important	very important	moderately important	not very important	not at all important

6) Could you give me an estimate on how much you have invested in your fishing equipment? [total, not including boat, if you own one]

$______________________

7) Do you own a boat? _____ yes _____ no

If yes, what percentage of time do you estimate you use your boat for fishing?

____

If yes, would you tell us how much your boat cost? [total including motor and accessories]

$_____________________________

8) How many times each year do go on **overnight** trips just to fish?

____

9) When you go on **vacation** trips, would you say that fishing is: (Please check one) [Ask until yes response]

the ONLY recreation activity you participate in
___ yes ___ no

the MAIN recreation activity you participate in
___ yes ___ no

not GENERALLY an activity you participate in
___yes ___ no

NEVER an activity you participate in
___ yes ___ no

10) Thinking about your free time, what percentage of that time do you spend fishing each year?

____

11) When you fish, who do you usually go with? (check one)

_____ go alone

_____ take (or go with) the family

_____ go with friends

_____ family **and** friends

_____ other, please specify ____________________________

____

12) Do you plan on eating any of the fish you catch today?

_____ yes _____ no _____ depends on what I catch

If yes, can you tell me which types of fish you will be eating?

____

____

If no, why not?

____

If no, what do you do with the fish you catch?

____

If depends, what type of fish would you eat?

____

13) Can you give me an estimate, in pounds, of the amount of fish you catch and eat each year **at this site.**

____

If give an estimate, what type of fish is it that you usually catch and eat?

____

14) If you caught the fish you **most** wanted to catch today, how would you prepare these fish to cook? [REFER TO QUESTION 2 IF NEED A REMINDER].

_____ I don't eat fish

_____ skin the fish before cooking

_____ scale the fish but leave the skin on

_____ remove belly flap

_____ fillet fish

_____ other (please explain) ______________________

____

15) How do you usually cook these fish?

_____ I don't eat fish

_____ cook the fish whole

_____ poach

_____ eat raw

_____ broil

_____ fry

_____ smoke

_____ other (please explain) ______________________

____

16) At this point we would like you to think about the **land** area surrounding the water you are fishing in today.

On a scale of one to ten with one being **UGLY** and ten being **BEAUTIFUL,** with the numbers in between being somewhere between ugly and beautiful, what number would you give this **land** area?

____

With one being **MAN-MADE** and ten being **NATURAL** how would you rate this **land** area?

____

With one being **DIRTY** and ten being **CLEAN** how would you rate this **land** area?

____

Now we would like you to think about the **WATER** in front of you.

On a scale of one to ten with one being **MUDDY** and ten being **CLEAR** with the numbers in between being somewhere between **MUDDY** and **CLEAR,** what number would you give the **water?**

____

With one being **DIRTY** and ten being **CLEAN** how would you rate this **water?**

____

With one being **FOUL** and ten being **FRAGRANT** how would you rate this **water?**

____

With one being **STALE** and ten being **FRESH** how would you rate this **water?**

____

Lastly, in your estimation, on a scale of one to ten, with one being **POOR** and ten being **EXCELLENT,** how would you rate the overall quality of the **water?**

____

17) Would you please tell me what you feel is the **worst** problem affecting the water quality of this river?

____

____

I'm now going to read you a series of statements that all relate to toxic chemicals. **Toxic chemicals are such things as PCB's, Lead or Dioxins that are sometimes found in the every day environment.** They all sound pretty close to each other in meaning so please ask me to repeat them as often as you need. I'll give you a card to help you remember the responses. [GIVE CARD TO PERSON]. I'm going to ask you if you **strongly, moderately or slightly agree or disagree** with each statement. There are **NO** right or wrong answers for these statements. We are very interested in **YOUR** opinions. [ENCOURAGE PEOPLE TO RESPOND TO THESE QUESTIONS EVEN IF THEY FEEL THEY ARE NOT FAMILIAR WITH TOXIC CHEMICALS. WE WILL ASK THEM HOW FAMILIAR THEY FEEL THEY ARE WITH TOXIC CHEMICALS LATER SO THEY SHOULDN'T WORRY ABOUT HURTING OUR RESULTS].

The **WATER** area I am fishing in now contains toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

It is **not** likely that I would get ill from consuming toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

The **FISH** in the water I am fishing in now contain toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

The **WATER** I am fishing in now contains dangerous levels of at least one toxic chemical.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

It is highly unlikely that the **FISH** in the water I am fishing in contain any toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

Consuming toxic chemicals in any amounts will make a person seriously ill.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

Compared to other water areas I fish, the level of toxic chemicals in this **WATER** area is low.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

The **FISH** in the water area I am fishing in now contain dangerous levels of toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

Toxic chemicals are **not** present in this **WATER.**

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

Compared to other water areas I fish the level of toxic chemicals in the **FISH** in this water area is low.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

It is possible to get sick from eating fish that contain toxic chemicals.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

There are large amounts of toxic chemicals present in this **WATER.**

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

FISH that contain toxic chemicals are always unsafe to eat.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

In general, the quality of the environment is improving.

Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree

18) How familiar would you say you are with toxic chemicals? [READ RESPONSES]

Extremely Familiar	Very Familiar	Somewhat Familiar	Not very Familiar	Not at all Familiar

Getting away from those types of questions...

19) Have you or anyone you know been made sick from fish you believe were contaminated by toxic chemicals?

_____ yes _____ no _____ don't remember

If yes, how many times has this happened to you or someone you know?

____

20) How would you determine if toxic chemicals were present in the environment?

____

____

21) If toxic chemicals were present in the fish you were **most** trying to catch today, would you keep those fish? [REFER TO QUESTION 2 IF A REMINDER IS NEEDED]

_____ yes _____ no _____ depends

If yes, would you eat those fish?

_____ yes _____ no

If yes, how would you prepare those fish to cook?

_____ I don't eat fish

_____ skin the fish before cooking

_____ scale the fish but leave the skin on

_____ remove belly flap

_____ fillet fish

_____ other (please explain) _________________________

____

If yes, how would you cook those fish?

_____ I don't eat fish _____ broil

_____ cook the fish whole _____ fry

_____ poach _____ smoke

_____ eat raw

_____ other (please explain) ____________________

____

If no, what will you do with those fish?

____

If depends, what type of fish would you keep? [ALSO ASK THE QUESTIONS FOR IF ANSWERED YES]

____

22) If you wanted or needed to find out about the possible dangers of consuming toxic chemicals where would you turn to find out this information?

____

23) If you were trying to avoid fish that contained toxic chemicals at this site, which types of fish would you avoid?

____

____

I'd like you to make one more rating now on the presence of toxic chemicals in this water.

24) With one being **NO TOXIC CHEMICALS** are present in this water and ten being **HIGH LEVELS OF TOXIC CHEMICALS** are present, how would you rate the level of toxic chemicals present in this water?

____

25) Did you get a chance to read the brochure that was given to you with your fishing license?

______yes ______no ______didn't get one _____don't know

If **yes,** did you read the warning about the presence of toxic chemicals in some fish in some Michigan water areas?

_____yes ______no ______don't remember

Lastly, we would like to get some information about your trip planning and about you yourself.

26) During the past year have you ever avoided fishing in waters in Michigan because you believed they were contaminated by toxic chemicals?

_____ yes _____ no _____ don't remember

If yes, can you tell us how many bodies of water you have avoided because you believed they were contaminated by toxic chemicals?

____

Would you please name these bodies of water?

____

____

27) If you knew that toxic chemicals were present **at this site** would this prevent you from fishing here?

_____ yes _____ no

If no, why not?

____

____

28) What is your home city, county, state and zip code?

____

29) What was the destination of the trip you are on?

____

30) Approximately how far is this site from your home?

___________ miles

Lastly, we need some general information about yourself...

31) Sex (check one)

_____ male _____ female

32) Age

_________ years

33) Race

___ Black ___ Hispanic ___ Oriental ___ White

_____ Other

34) Marital status?

_____ married _____ single _____ divorced

_____ other (please specify) ________________________

35) What do you do for a living?

____

36) Can you tell me how many years of school you completed?

____

37) Would you please give an estimate of your annual family income before taxes?

$________________________

OPTIONAL (FILL OUT YOURSELF):

NUMBER OF FISH CAUGHT BY RESPONDENT ______________

TYPES OF FISH CAUGHT BY RESPONDENT ______________________

____

YOUR OWN IMPRESSION ON HOW GOOD THE RIVER IS TO FISH TODAY (i.e. are people generally successful in catching fish today?)

____

REFERENCES

REFERENCES

Bailey, K.D. Methods of Social Research. New York: The Free Press, 1978.

Baker, E.J., West, S.G., Moss, D.J. and Weyant, J.M. Impact of Offshore Nuclear Power Plants: Forecasting Visits to Nearby Beaches. Environment and Behavior. 1980, 12(3), pp. 367-407.

Barker, M.L. Beach Pollution in the Toronto Region. In W.R.D. Sewell and I. Burton (eds), Perceptions and Attitudes in Resource Management. Ottawa: Dept. of Energy, Mines and Resources, 1970, pp. 37-47.

Baum, A., Fleming, R. and Davidson, L.M. Natural Disaster and Technological Catastrophe. Environment and Behavior. 15(3), 1983, pp. 333-354.

Bell, P.A., Fisher, J.D. and Loomis, R.J. Environmental Psychology. Philadelphia: W.B. Saunders Company, 1978.

Blalock, H.M. Social Statistics. New York: McGraw-Hill Book Company, 1979.

Blanchard, J.J. Michigan State of the State Message. Lansing: Michigan Office of the Governor, 1985.

Brown, P.J., Driver, B.L. and McConnell. The Opportunity Spectrum Concept and Behavioral Information in Outdoor Recreation Resource Supply Inventories: Background and Application. In H.G. Lund, V.J. Labau, P.F. Ffolliott and D.W. Robinson (eds), Integrated Inventories of Renewable Resources: Proceedings of the Workshop. USDA Forest Service General Technical Report RM-55, January, 1978, pp. 73-84.

Bryan, H. Conflict in the Great Outdoors. Birmingham: The Birmingham Publishing Company, 1979.

Burton, I., Kates, R.W. and White, G.F. The Environment as Hazard. New York: Oxford Press, 1978.

Burton, I. Cultural and Personality Variables in the Perception of Natural Hazards. In J.F. Wohlwill and D.H. Carson (eds), Environment and the Social Sciences: Perspectives and Applications. Washington D.C.: American Psychological Association, Inc., 1972, pp. 184-197.

Cheron, E.J. and Ritchie, J.R.B. Leisure Activities and Perceived Risks. Journal of Leisure Research. 1982, 14(2), pp. 139-154.

Clark, R.N. and Stankey, G.H. The Recreation Opportunity Spectrum: A Framework for Planning, Management, and Research. USDA Forest Service, General Technical Report PNW-98, December, 1979.

Collins, R.L. The Strategy for Cleaning Up Our Waters. In T.Y. Toribara et al. (eds), Environmental Pollutants. New York: Plenum Press, 1978, pp. 19-35.

Crabb, J. Statistics Consultation. Department of Statistics. Kansas State University. Manhattan, KS, 9/17/85.

Drew, C.J. Introduction to Designing and Conducting Research. St. Louis: The C.V. Mosby Company, 1980.

Driver, B.L. and Brown, P.J. The Opportunity Spectrum Concept and Behavioral Information in Outdoor Recreation Resource Supply Inventories: A Rationale. In H.G. Lund, V.J. Labau, P.F. Ffolliott and D.W. Robinson (eds), Integrated Inventories of Renewable Resources: Proceedings of the Workshop. USDA Forest Service General Technical Report RM-55, January, 1978, pp. 24-31.

Driver, B.L. and Knopf, R.C. Temporary Escape: One Product of Sport Fisheries Management. Fisheries. 1976, 1(2), pp. 21-29.

Eckholm, E.P. Down To Earth. New York: W. W. Norton & Co., 1982.

Einhorn, H.J. and Hogarth, R.M. Behavioral Decision Theory: Processes of Judgement and Choice. Annual Review of Psychology. Palo Alto: Annual Reviews, Inc, 1981, Vol. 32, pp. 53-88.

Evans, G.W. and Jacobs, S.V. Air Pollution and Human Behavior. Journal of Social Issues. 1981, 37(1), pp. 95-125.

Festinger, L. A Theory of Cognitive Dissonance. Stanford, CA: Stanford University Press, 1957.

Gunter, B.G. Properties of the Leisure Experience. In Ibrahim, H. and Crandall, R. (eds) Leisure: A Psychological Approach. Los Alamitos: Hwong Publishing Company, 1979, pp. 3-43.

Haber, R.N. and Hershenson. The Psychology of Visual Perception. New York: Holt, Rinehart and Winston, Inc., 1973.

Hanson, S., Vitek, J.P. and Hanson, P.O. Natural Disaster: Long-Range Impact on Human Response to Future Disaster Threats. Environment and Behavior, 1979, 11(2), 268-284.

Hansson, R.O., Noulles, D. and Bellovich, S.J. Knowledge, Warning and Stress: A Study of Comparative Roles in an Urban Floodplain. Environment and Behavior, 1982, 14(2), 171-185.

Harper, W. The Experience of Leisure. Leisure Sciences. 1981, 4(2), pp.113-126.

Hendee, J.C., Clark, R.N. and Dailey, T.E. Fishing and Other Recreation Behavior at High-Mountain Lakes in Washington State. USDA Forest Service, Pacific North West Forest and Range Experiment PNW-304, November, 1977.

Hesse, J. L. Polychlorinated Biphenyl Usage and Sources of Loss to the Environment in Michigan. In National Conference on Polychlorinated Biphenyls. Environmental Protection Agency, Washington D.C., March, 1976, pp. 127-123.

Hewitt, K. and Burton, I. The Hazardousness of a Place: A Regional Ecology of Damaging Events. Toronto: University of Toronto Press, 1971.

Holdgate, M.W.; Kassas, M. and White, G.G. (eds), The World Environment Programme. Dublin: Tycooly International Publishing Limited, 1982.

Jackson, E.L. Response to Earthquake Hazard: The West Coast of North America. Environment and Behavior, 1981, 13(4), pp. 387-416.

James, G.A., Nelson, W.T. and Hopkins, M.L. Estimating Recreational Use of a Unique Trout Stream in the Coastal Plains of South Carolina. USDA Forest Service Research Note SE - 159, May, 1971.

Jubenville, A. Outdoor Recreation Management. Philadelphia: W.B. Saunders Company, 1978.

Kopp, T. E. PCB Disposal, Reclaiming, and Treatment. In National Conference on Polychlorinated Biphenyls. Environmental Protection Agency, Washington D.C., March, 1976, pp. 108-123.

Kolers, P.A. Perception and Representation. Annual Review of Psychology. Palo Alto: Annual Review, Inc., Vol. 34, 1983, pp. 129-166.

Levy-Leboyer, C. Psychology and Environment. Beverly Hills: SAGE Publications, Inc., 1982.

Logue, J.N., Melick, M.E. and Hansen, H. Research Issues and Directions in the Epidemiology of Health Effects of Disasters. Epidemiologic Reviews. 1981, 3, pp. 140-162.

Lucas, R.C. Recreation Regulations - When Are They Needed? Journal of Forestry. 1982, 80(3), pp. 148-151.

Mahoney, E., Jester, D. and Kikuchi, H. Fisheries Report. Michigan Department of Natural Resources, Fisheries Division, (in preparation).

Manfredo, M.J., Brown, P.J. and Haas, G.E. Fisherman Values in Wilderness. In Proceedings of the Western Association of Fish and Wildlife Agencies and the Western Division American Fisheries Society. San Diego, July, 1978, pp. 276-297.

Marty, R. Administrating Public Lands and Resources. Unpublished manuscript, Michigan State University, Department of Forestry, 1982.

Michigan Department of Natural Resources. Michigan Fishing Guide: 1983. Lansing: State of Michigan, 1984a.

Michigan Department of Natural Resources. Hazardous Waste Management in Michigan. Lansing: State of Michigan, 1984b

Mieure, J. P., Hicks, O., Kaley, R. G., and Saeger, V. W. Characterization of Polychlorinated Biphenyls. In National Conference on Polychlorinated Biphenyls. Environmental Protection Agency, Washington D.C., March, 1976, pp. 84-93.

Mitchell, J.K. Natural Hazards Research. In I.R. Manners and M.W. Mikesell (Eds), Perspectives on Environment. Washington D.C.: Association of American Geographers, 1974, pp. 311-341.

Moeller, G.H. and Engelken, J.H. What Fishermen Look For in a Fishing Experience. The Journal of Wildlife Management. 1972, 38(4), pp. 1253-1257.

Moser, C.A. and Kalton, G. Survey Methods in Social Investigation. New York: Basic Books, Inc., 1972.

Neter, J. and Wasserman, W. Applied Linear Statistical Models. Homewood, IL: Richard D. Irwin, Inc., 1974.

Nunnally, J.C. Psychometric Theory. New York: McGraw-Hill Book Company, 1978.

O'Muircheartaigh, C.A. Statistical Analysis in the Context of Survey Research. In C.A. O'Muircheartaigh and C. Payne (eds), The Analysis of Survey Data: Volume 1 Exploring Data Structures. New York: John Wiley & Sons, 1978.

Ott, W. R. Environmental Indices: Theory and Practice. Ann Arbor: Ann Arbor Science Publishers Inc., 1978.

Payne, J.W. Contingent Decision Behavior. Psychological Bulletin. 92(2), 1982, pp. 382-402.

Preston, V., Taylor, S.M. and Hodge, D.C. Adjustment to Natural and Technological Hazards: A Study of an Urban Residential Community. Environment and Behavior. 15(2), 1983, pp. 143-164.

Rothbaum, F., Weistz, J.R. and Snyder, S.S. Changing the World and Changing the Self: A Two-Process Model of Perceived Control. Journal of Personality and Social Psychology. 42(1), 1982, pp. 5-37.

Schweitzer, G.E. Toxic Chemicals: Steps Toward Their Evaluation and Control. In, Environmental Protection: The International Dimension. Totowa: Allanheld, Osmun & Co., Publishers, Inc., 1983, pp.22-24.

Shippee, G., Burroughs, J. and Wakefield. Dissonance Theory Revisited: Perception of Environmental Hazards in Residential Areas. Environment and Behavior. 12(1), 1980, pp. 33-51.

Shulstad, R.N. and Stoevener, H.H. The Effects of Mercury Contamination in Pheasants on the Value of Pheasant Hunting in Oregon. Land Economics. 1978, 54(1), pp.39-49.

Sims, J.H. and Baumann, D.D. Educational Programs and Human Response to Natural Hazards. Environment and Behavior. 15(2), 1983, pp. 165-189.

Slovic, P., Kunreuther, H. and White, G.F. Decision Processes, Rationality and Adjustments to Natural Hazards. In Gilbert F. White (ed) Natural Hazards: Local, National, Global. New York: Oxford Press, 1974, pp. 187-205.

Sorensen, J.H. Knowing How to Behave Under the Threat of Disaster. Environment and Behavior. 15(4), 1983, pp. 438-439.

Spector, P.E. Behavior in Organizations as a Function of Employee's Locus of Control. Psychological Bulletin. 91(1), 1982, pp. 482-497.

Stynes, D.J., Spotts, D.M. and Strunk, J.R. Relaxing Assumptions of Perfect Information in Park Visitation Models. Professional Geographer. 37(1), 1985, pp.21-28.

Sudman, S. Applied Sampling. New York: Academic Press, 1975.

Swartz, D.G. and Strand, I.E. Avoidance Costs Associated with Imperfect Information: The Case of Kepone. Land Economics. 1981, 57(2), pp.139-150.

Svenson, O. and Fischhoff, B. Levels of Environmental Decisions. Journal of Environmental Psychology. 1985, 5(1), pp.55-68.

Train, R. E. Environmental Protection Prescription for Health. In _National Conference on Polychloriated Biphenyls_. Environmental Protection Agency, Washington D.C., March, 1976, pp.7-9.

Udd, E. and Fridgen, J.D. Anglers' Perceptions of Toxic Chemicals in Rivers and Sports Fish. Paper to be published in the _Proceedings of the National Wilderness Conference_. Fort Collins, CO, July 22-25, 1985.

White, G.F. Natural Hazards Research: Concepts, Methods, and Policy Implications. In G.F. White (ed) _Natural Hazards: Local, National, Global_. New York: Oxford University Press, 1974, pp. 3-16.

Wilford, W. A., Hesselberg, R. J. and Nicholson. Trends of Polychlorinated Biphenyls in three Lake Michigan Fishes. In _National Conference on Polychlorinated Biphenyls_. Environmental Protection Agency, Washington D.C., March, 1976, pp. 177-181.