The effects of water quality improvement on outdoor recreational demand

by

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CHAPTER I. INTRODUCTION

Outdoor recreation is one of the fastest growing uses of natural resources in America today. There appears to be a tendency to consider the quality, as well as, the quantity of natural resources in people's preferences. The enhancement of recreational resources is inherent in the current discussions on environmental quality. In light of increasing demands for natural resources, and particularly the quality to be demanded for recreational uses, a problem of allocation among the competing uses is present. It is the general purpose of this study to probe into the quality of natural resources in satisfying recreational demands of the people. Specifically, water resource quality with respect to recreational development in the proposed Ames Reservoir region is used to carry out this purpose.

Importance of Recreational Quality

With increasing urbanization, more leisure time, and greater affluency of our society, coupled with the deterioration of environmental quality, there is a legitimate desire for outdoor recreation. This demand for outdoor recreation is increasing throughout the nation and is expected to do so in the future (7, p. 4). To meet this demand present recreational areas will have to be maintained and new sites developed.

Development of natural resources may bring conflicts between the goals of economic development and environmental quality. Economic growth requires the use of large amounts of natural resources. As these resources are consumed to produce technological goods the quality of the environment often declines. However, with development of natural resources for outdoor recreational purposes a somewhat different situation may arise. Although developing natural resources for outdoor recreational purposes is a form of resource use and contributes to economic growth, the quality of the recreational resource must be of a certain level for providing recreational services.

This poses the question of what quality level is desired for recreational resources? There is a wide range of quality that represent recreational resources. Nonetheless, quality is a dimension that applies to all recreational resources. National parks are characterized by their unique qualities. In areas of less natural wonder, like reservoirs, quality is dependent in part upon the region of the country, its climate, vegetation, and other environmental characteristics. Other areas, such as playgrounds, that are used intensively often represent a quality that embodies developmental programs by Man (7, p. 164).

Recreational resource quality is difficult to define. One definition is to consider recreational resource quality as a demand-oriented concept with the various recreational uses or activities having different quality requirements. For instance, many recreational activities are associated with water resources. According to Timmons, water resource quality is a general term that "...means the properties of water which influence its use" (51, p. 34).

Two types of water-oriented recreational uses have been suggested with respect to water quality. They are primary contact and secondary contact recreation. Primary contact recreation includes activities involving prolonged body contact with the water. With this type of recreation there is considerable risk of ingesting water in sufficient quantities to be a health concern. These activities include such things as swimming, wading, diving, and water skiing. Secondary contact recreation activities are those where body contact with the water is only incidental or accidental. The probability of ingesting water in significant quantities is low. These activities include fishing, pleasure boating, picnicking, hiking, camping, and winter activities on the ice (14, p. 6).

There are a variety of materials that affect the quality of water resources. Eight classes can be specified: (1) sewage feedlot runoff and other oxygen demanding wastes, (2) infectious agents, (3) plant nutrients, (4) organic chemical exotics, (5) other mineral and chemical substances, (6) sediments, (7) radioactive substances, and (8) heat (54, p. 297). All of these can have a degrading effect on water-oriented recreational resources.

Soil as sediment, particles forming colloidal suspensions with their transport medium, has been identified as the factor causing the most damage to streams, lakes, and harbors (54, p. 291). It is estimated that 4 billion tons of sediment enter the nation's waterways each year (61, p. 36). This sediment load comes from about 600 million acres on roughly one third the land area of the United States. These suspended solids amount to at least 700 times the total sewage discharge of this country.

Several recent researchers (25, 43) have studied the effects of sediment and associated materials on the quality of streams in Iowa. These associated materials are within the first five classes identified above. Sediment reduces the capacity of many water resources, such as reservoirs, thus limiting outdoor recreational participation. To some extent the quality of fishing has declined due to increasing sedimentation (55, p. 147-148). The level of dissolved oxygen is affected by suspended sediment. As a result, commercial and game fishing areas may become damaged (13). Swimming requires a more stringent quality level than fishing (10, p. 189). Relatively clear water, although not necessary, is desirable from the standpoint of visual appeal, recreational enjoyment, and safety (55, p. 144).

If other transported materials from the agricultural sector are considered such as, pesticides and sewage, a health hazard may exist. Already mentioned is the characteristic of suspended soil sediment forming a colloidal suspension. By adsorption this suspension can transport other potentially harmful materials, such as pesticides. The combined effect can have a greater impact than if the materials were separated. This phenomenon is called synergism (8, p. 30).

Obviously there is a need to relate the physical parameters of natural resource quality to the decision framework of outdoor recreation. There appears to be little disagreement with the statement that the individual's demand for outdoor recreation is somehow affected by quality. The problem is how can the quality demanded or supplied in a recreational experience of a recreational activity be measured? Over the centuries much debate has been carried out in attempting to determine the differences and likenesses of 'quality' and 'quantity'. Aristotle believed "...that quality was the basis for saying that things are like or unlike, similar or dissimilar, whereas, quantity was the basis for saying that they are equal or unequal" (49, p. 65). A counter argument is evident if qualities are subject to variations in intensity or degree, is not this variation equivalent to a quantitative change? This study takes the affirmative answer to this question. That is, some degree of quantitative measurement of the quality characteristics involved in the recreational experience is possible although difficult.[1] According to Griliches, the quality of a commodity can be considered to be a composite of a number of different characteristics, each of which may be objectively measured or ranked (as cited in 49, p. 65). Inclusion of specified quality variables is needed to develop recreational demands that are quality determined.

Recreational Resource Alternatives

Allocation and development of natural resources for outdoor recreation is complicated by society's numerous competing uses for these resources. Economics has much to offer in deciding how these scarce resources may be allocated in maximizing society's welfare over time.

Outdoor recreation is not the only use of a particular resource. In many instances recreational activity is secondary to that of other uses, i.e., timber production, grazing, watershed protection, and mining. These other uses each have their own demand schedule and in some cases these demands are complementary, neutral, or competitive with respect to outdoor recreational quality. An example of competitive uses would be when a stream or river is used as a sewer curtailing or eliminating recreation,

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[1]Measurement of recreational benefits is discussed in a subsequent chapter.

or causing downstream water users to assume costs to return the water to a quality level sufficient for recreation. In addition, there can be different demands within the recreation spectrum. For instance, due to the increasing demand for water-oriented outdoor recreation and the diversity of recreational activities, conflicts over allocation between stream recreation and reservoir recreation have resulted. Even at a particular recreation site incompatible (competitive) recreational activities may occur such as water skiing and fishing. Often these recreational activities require different quality dimensions.

Before commitment of a natural resource to a particular recreational opportunity or project the alternatives should be studied. Knowledge of the public's demand for the alternative forms of outdoor recreation would help in assessing the problem. Prediction of future demands should not be carried too far into the future as the tastes of recreationists can change over time. Therefore, flexibility should be designed into any resource developed for recreational purposes. This would lessen the chances of endangering the overall success of a recreational development due to demand failure of one component.

An example of alternative outdoor recreational development would be reservoir type recreation versus stream type recreation. In the planning of a reservoir, alternative stream recreational activities should be assessed as to their recreational value or demand. If it was shown that demand was appreciable for the stream form of recreation, consideration should be given to this alternative recreational facility. This scheme would be reversible. A reservoir could be built subsequently if recreationists' preferences changed.

The problematic situation

Our society appears to be moving towards demanding something more than continued economic growth. Concepts of "GNP" and "national income" may well be modified to consider not only material quantity, but the calculus of the quality of life. According to Professor Paul Samuelson, net economic welfare (NEW) is the corrected version of GNP (40, p. 102). This correction accounts for such disamenities as the deterioration of environmental quality and the valuation of items like expanded leisure. The quality of life, rather than increasing per capita consumption of final goods and services, is becoming ever more important.

Both the demand for technological goods and the demand for the amenities from the environment will likely continue to increase along with the population and the population's income. Increased leisure time will mean increased demand for outdoor recreation. Although if outdoor recreational demand is partially dependent upon environmental quality and its associated amenities there then exists a need to preserve this quality. This can be accomplished by employing institutional authority and economic devices.

Research has been conducted in various fields in the specification of water quality, but little has been done in determining the effects of poor water quality on recreation (49, p. 6). The optimal quality level of recreation remains unanswered. Jacobs stated, "...the question of the optimal level of water quality management remains unanswered because of the public nature of quality management and the unmeasured reaction and aesthetic benefits" (25, pp. 1-2).

According to the 1966 preliminary plan of the Iowa Conservation Commission:

> There are...other sociological and economical factors which undoubtedly affect recreational demand...however, the effect of these factors on recreation has apparently not been measured or studied in Iowa, and it is felt that some studies will be necessary before any specific recommendations can be based on these factors (62, p. 4).

The problem of major concern in this study is to show that natural resource quality affects demand for outdoor recreation. Specifically for this study, the proposed Ames Reservoir on the Skunk River and the alternative "green-belt" type of recreational area between the towns of Story City and Ames are analyzed. Consumer preferences as to type of recreational form and quality are examined.

Objectives of the Study

This study attempts to relate the physical qualities of recreational resources to the preferences of the public. The objectives of this study are:

1. To review the nature of outdoor recreational quality and to review the methods for estimating demands for outdoor recreation.
2. To develop and apply methods in appraising the quality of water and associated recreational resources in relation to recreation sites as demanded by the people.
3. To draw inferences from the study for the improvement of natural resources in relation to the demands for these resources.
4. To suggest additional research as needed to understand the quantity and quality components of recreational resources.

The first objective requires the specification of what outdoor recreational quality is. Various methods for estimating recreational demands and benefits have been developed, although none are entirely satisfactory in measuring the economic value of recreation. The strengths and weaknesses of these methods are delineated.

The second and third objectives assume that quality is an important parameter in determining the demand for outdoor recreation. Quality levels of recreational resources can be maintained by implementing improved management practices. The fourth objective suggests further research needs as indicated by the analysis.

Methods and Procedures

In pursuing the objectives of this study the quality of recreational opportunity and its associated demand are emphasized. Water quality will be considered since many recreational activities are linked to this resource. More specifically the free flowing stream and "green-belt" type of recreational areas are stressed. Data collection for the quality preferences of recreation were obtained through a survey by personal interviews in central Iowa. The aesthetic aspects of environmental quality in relation to the proposed Ames Reservoir were studied by Schellenberg (42). A "green-belt" park system was formulated as an alternative to the multipurpose project. Recreational attendance and benefits were estimated at this proposed park facility with the present level of water quality. For the purposes of this present study the survey was expanded to include improvements in water quality and subsequent impacts on visitation and benefits (see interview questions in Appendix A).

Income, population, age, and distance to the site, important factors of outdoor recreation demand, are analyzed for their significance with respect to recreational water quality.

Organization of the Study

This initial chapter introduces the concept of recreational quality. Society is demanding more recreation. Present recreational areas will have to be maintained and expanded, and new areas developed. The existing quality of many recreational areas appears inferior to societal demands and preferences. In other words, a gap or problem exists concerning the quality of our recreational areas.

Chapter II discusses the scope of the problem in the physical, economic and institutional aspects. Water resource quality is stressed since many outdoor recreational opportunities are associated with it. Suspended sediment and associated pollutants is the criteria of water quality used. In addition, there is mention of other factors influencing recreational water quality. Resource allocation theory, the basic subject of welfare economics, is discussed here. Examination of the institutional abilities in preserving and administering recreational resource quality is presented.

Development of the analytical model and its application to study area, and resulting empirical findings will be the content of Chapter III. Chapter IV discusses the alternatives within the river basin context and considers the effects of improved water quality. This chapter suggests how the results could be applied to the Skunk River region of the proposed Ames Reservoir.

Chapter V comprises summary, conclusions, and limitations of the study.

CHAPTER II. RECREATIONAL RESOURCE QUALITY

Dimensions of the Problem

Analysis of outdoor recreational quality and the natural resources used for outdoor recreation may be aided through a three-dimensional framework. These three dimensions are (1) physical (biological and technological), (2) economic, and (3) structural (institutional) forms. None of these dimensions are independent of one another, rather they are all interrelated. Hence, if effective management of recreational quality is desired both the physical sciences and social sciences are necessarily involved in the analysis of the problem. The interrelationships are illustrated in Figure 2.1 and the interaction among the three dimensions is discussed in the next section.

The Interrelationships of the Three Dimensions

Recreational resources, natural resources where outdoor recreational opportunities exist, possess certain qualities. Preservation of these qualities requires managerial considerations of what are the present physical conditions and what is physically possible, what is economically feasible, and institutionally permissible.

The physical dimension of resources used for recreational purposes can be maintained and improved in terms of what is technologically possible. Solutions to many of this country's deteriorated natural resources is not beyond the innovative capabilities of technology. For instance, technologically developed structures can diminish or eliminate

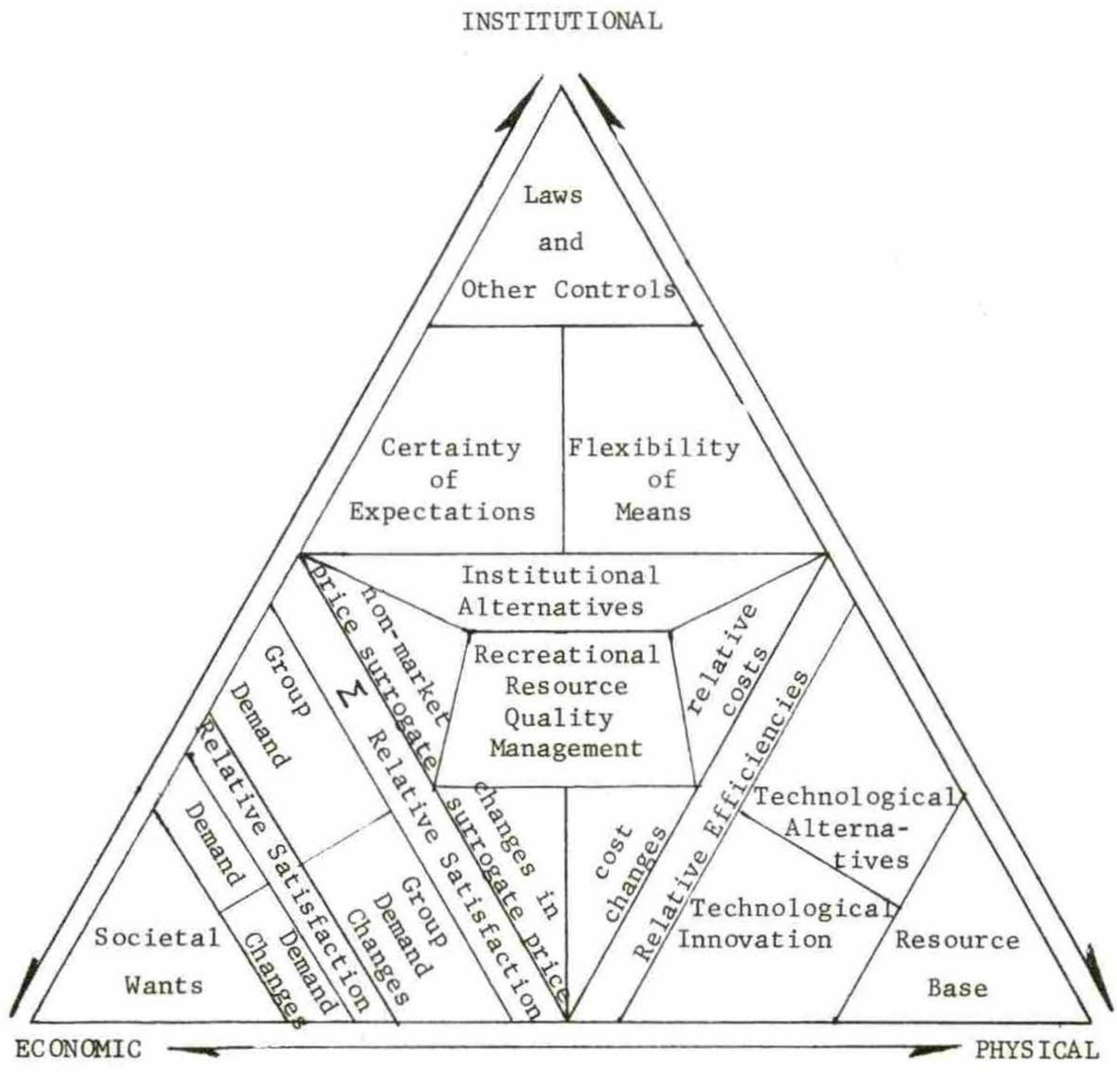

Figure 2.1. Conceptual illustration of the physical, economic, and institutional interrelationships in recreational resource quality management (adapted from Timmons, 50, p. 172)

the amount of effluents entering water resources, i.e., sewage treatment facilities, soil erosion stabilization structures, cooling sinks for heated waters, etc. However, with some recreational areas the natural state of the resource must remain intact to be appreciated by people participating in the area. In some cases technological progress has put a limit on the supply of recreational resources by deteriorating their quality. A canyon that is inundated by reservoir waters loses the natural environment and the recreational opportunities that the canyon provided.

Technology offers various possible solutions to the problem, but it cannot by itself make a choice nor can it determine the economic consequences of the several choices. Decision on which of the choices is economically feasible is aided by inquiries into the economic dimension (52, p. 668).

If the physical dimension is understood economic analysis can help society allocate its natural-resources to outdoor recreation in a more efficient manner. Alternative development plans of recreational resources can be studied for their feasibility and thus limiting the probability of choosing an inefficient allocation. Economic conflicts over the use of a recreational area can also lead to deterioration of quality. High intensity or mass recreation provides the greatest financial returns, but the aesthetic aspects of the recreational area are often lost.

Management of outdoor recreational quality is the function of various institutions. Awareness of recreational quality in terms of the physical aspects and economic alternatives is important if the various agencies involved want to accomplish desired maintenance levels and improvement goals. Legislation concerning quality can be weakly enforced resulting in resource degradation. The complexity of institutions with their limited and sometimes overlapping jurisdictions limit their effectiveness, i.e., there are numerous federal agencies administering this nation's 725 million acres of public lands. Also what is good for resource quality can be politically unattractive. For instance, the establishment of a federally financed recreational lake may be more appealing than another recreational alternative, like a woodland park, that would be established by local funds.

Each of the three dimensions with respect to quality of water-oriented recreational resources is discussed in the following sections.

The Physical Dimension

In the broadest sense, the physical supply of recreation could be the total of the nation's land and water area. Space and scenery are attributes of all natural resources. Considering water-oriented recreational resources this country has many streams and rivers, natural lakes, and man-made reservoirs. The physical quality of these resources ranges from pristine mountain lakes to sediment-filled reservoirs. This section concentrates on the physical aspects of natural resources used for water oriented recreational activities.

The natural supply of water comes from four sources. The most obvious is direct precipitation on the body of water in the form of rain or snow. Direct surface runoff is a second source, which is the result of some of the precipitation flowing overland to the body of water. If the precipitation is in excessive amounts and/or rates, flooding can result. A third source is interflow or subsurface flow. This is the lateral movement of water under the earth's surface following surface infiltration. For subsurface flow to occur a relatively impermeable stratum in the subsoil is required which prevents downward percolation as found in forested mountainous zones. Movement of water to the stream or lake is caused by the force of gravity. Finally, the fourth source is ground water. At a relatively slow rate ground water enters the stream or lake through the process of infiltration, percolation, and seepage discharge. Although the sources have been classified they are not necessarily independent of each other, i.e., precipitation may begin as surface runoff, but enters the body of water as ground water (15, pp. I-1-2).

Water usage with respect to recreational activity is extremely varied. Two general types of uses for water in the recreation spectrum are observed. First water is used in recreation as a medium on or in which recreational activities occur. These activities include fishing, hunting, boating, swimming, and a wide array of other associated activities. As mentioned in the previous chapter such activities can be divided into primary and secondary contact categories. The second general type of use is that in which water provides principally the background or setting enhancing the intrinsic satisfaction that is derived from any recreational activity. Here water is considered a scenic asset and related to the wilderness environment (58, p. 3). The corresponding quality requirements for these general types of uses and the many activities therein are also widely varied.

The quality of water resources is affected by both natural processes and Man's activities. These include usage, natural pollution, drainage of urban and agricultural lands, waste solid disposal practices, recreational activities, and certain political implementations (20, p. 481). Though not necessarily, impairment of water quality results from the above practices and processes.

Water quality may be obvious or rather subtle. A body of water emanating offensive odors will offer little in the way of recreational opportunity. A stream or lake that is clear, without odor, color, or taste, may also be unfit for recreation. Such water resources may be unhealthy and unsuitable to support aquatic life. According to a report to the Outdoor Recreational Resources Review Commission, (ORRRC), a healthy body of water:

> ...contains aquatic life that lives, breathes, and expels the waste products. Aquatic plants utilize carbon dioxide, water, and sunlight, during the sunlight hours to create plant growth and to generate oxygen. Oxygen also is absorbed from the air into water. Oxygen dissolved in water is a prime necessity for fish. Nitrogenous wastes from aquatic life dissolve in the water and serve, with the other dissolved minerals in water, as nutrients for plants. Small aquatic plants and animals serve as food for insects, fish, and waterfowl which use the stream for sustenance. Thus, a healthy body of water will contain plants such as algae which serve as food for larger animals, insects, and fish - all of which can impart taste, color, and odor to the water (58, p. 14).

Numerous factors cause the absence of aquatic life. The deposition of sediment over the water's biologic microcosm, the addition of harmful chemicals, and raising the water's temperature all may destroy aquatic life. Such water resources should be suspect for many forms of recreational activities (58, p. 14).

Sediment as a factor of recreational water quality

Sediment is one of the more common materials affecting water-oriented recreational resource quality. Clarity of recreational waters is highly desirable for visual appeal, recreational enjoyment, and safety. Seay stated, "The aesthetic value of lakes, ponds, and streams varies inversely with their turbidity level" (43, p. 17). For primary contact recreational waters a visibility standard of at least four feet is recommended.[1] In areas where beginners swim clarity should be such that the bottom is visible (55, p. 144). Suspended sediment affects the water's level of dissolved oxygen and thus limits the water's capacity to assimilate oxygen-demanding substances. As a result the fish population is damaged both in quantity and quality. One investigation found that maximum fish production occurred in farm ponds where the average turbidity was less than 25 Jackson Turbidity Units (J.T.U.).[2] If the quality dropped to more than 100 JTU fish yield was only 18 percent of clear ponds (55, p. 147-148). If the dissolved oxygen level is below 3.0 ppm a well-rounded fish population does not occur, but below 2.0 ppm of dissolved oxygen fish cease to exist (58, p. 17). In addition, there are

[1]Device used to measure clarity is Secchi disc.
[2]Measurement made on Jackson candle turbidimeter.

other conditions that should be met for a favorable environment for fish. For instance, if quality deteriorating cyanide salts or certain pathogens are present the water will be unsuitable for fishing as well as other recreational activities, no matter what the dissolved oxygen level is (10, p. 189).

Erosion and sediment Physically erosion is the detachment of soil particles from the surface soil mass by a transporting agent, i.e., water or wind. The action by water is by far the biggest culprit. The soil as sediment forms a colloidal suspension with the transport medium of water. By adsorption the colloidal suspension can carry chemical nutrients, organic exotics, and other quality deteriorating materials.

The principal sources of sediment can be classified into two categories; geologic erosion and mechanical erosion. Geologic or natural erosion comes from the activities of nature. Although contributing to the total sediment load, geologic erosion has caused some unique scenic spectaculars such as the Grand Canyon and the South Dakota Badlands (43, p. 17). Mechanical erosion is caused by Man's practices with the soil. Specifically these practices are agricultural development, urbanization development, and wastes from mining. This form is an accelerated erosion which occurs above the natural rate.

Naturally there are many factors which affect the amount and rate of physical loss of soil. They are: (1) the amount, intensity, and duration of rainfall, (2) the land-use and kind of vegetative cover, (3) the amount and velocity of surface flow, (4) the nature of the soil, and (5) the steepness and length of the land surface's slope.

Control of sediment yield   Much research is still necessary in understanding the problem of soil erosion and sediment transport mechanics (43, p. 24). However, two principal methods of controlling sediment are available. One is controlling the amount of soil displaced by erosion by using land treatment practices, such as contour farming, rotation, pasture improvements, terracing, and tree planting. The other method is control by engineering structures. These include gully stabilization structures, desilting basins, and reservoirs (58, p. 19).

Temperature as a factor of recreational water quality

The disposal of thermal waste from industry is a growing water quality problem. Industry uses more than 94 percent of the water withdrawn in this country. Of this only 2 percent is consumed and the remainder is warmed water that is returned to the nation's water resources[1] (58, p. 16).

Heat reduces the water's ability to hold oxygen in solution. As a result there are increased effects of organic pollution on the surface of the water. Also there are harmful effects on the fish population. Most fish species can only tolerate small changes in temperature. If there is a substantial increase in temperature the fish population can completely change or simply cease to exist (15, p. I-108).

Temperatures between 60° F and 85° F are approximately the range of ordinary recreational usage. However, temperatures that are outside this range pose a real health hazard. As the temperatures diverge from this

[1]The extent of warming can be approximated by finding the difference between the mean monthly air temperature and mean water resource temperature.

range "psycho-physiological" disturbances occur limiting the performance of persons participating in primary contact recreation. At extreme temperatures physiological strain to the heart and circulation system occurs, sometimes culminating in shock and even death (55, p. 133).

Chemicals as a factor of recreational water quality

The effect of chemicals upon the quality of recreational waters depends on several factors. First, is the volume and strength of the chemical in the body water. Obviously, a small volume of a weak concentration is less resource deteriorating than a large volume of a strong concentration. A second factor is the rate of discharge of the receiving stream and the volume of the receiving body is able to dilute quality destroying chemicals. Third, is the fact that different recreational activities can have varied acceptable chemical levels. Certainly waters used for boating can contain more toxic chemicals than swimming waters. Finally, the properties of the chemical itself affect the water quality. For example, sodium cyanide will cause infinitely more damage than sodium chloride given equal amounts (58, p. 15).

The sources of chemicals found in the water resources are numerous. Three major sources can be identified. They are the mining of ores, coals, and oil; effluents of manufacturing, refining, and processing industries; and pesticides and fertilizers that principally come from the agricultural sector. For the purpose of this study mention of oil as a factor influencing recreational water quality is made leaving the principal discussion on pesticides and fertilizers.

Oil Oily substances coming from drilling operations in coastal waters, seepage from natural underwater oil deposits, discharges from oil tankers, and industrial waste all contribute to the degradation of water quality. Oily waters are detrimental to water fowl, fish and aquatic life (58, p. 10). Although the presence of oil does not necessarily stop swimming and boating, the unpleasant odors and obnoxious taste diminish the recreationist's satisfaction. There is a lack of knowledge in the literature on the effects oil and related substances have on humans with respect to primary contact recreation. It is known that toxicity of these oily substances is low except in the case of aromatic compounds.

Pesticides and fertilizers Primary contact recreational activity is not considered to be significantly jeopardized by the presence of pesticides. This is because in most cases the concentrations that are considered danger levels are far in excess of water solubility (55, p. 1). However, several reports indicate that insecticides have caused substantial damage to fish populations. Cottom reported that out of 200 fish kills 38 percent were caused by pesticides (as cited in 58, p. 16). Young and Nicholson found tremendous fish losses after 26 million pounds of insecticides were applied to 400,000 acres of cotton in Alabama (as cited in 58, p. 16).

Pesticides can be divided into two classes; chlorinated hydrocarbons and organic phosphorous compounds. Chlorinated hydrocarbons include DDT, lindane, chlordane, chlorobenzilate, TDE (DDD), dilan, aldrin, dieldrin, endrin, heptachlor, and methoxychlor. Organo-phosphorous compounds include parathion, chlorothion, demeton, diazinon, and Dipterex which are among the most toxic to man.

There are several ways in which pesticides enter the water body; direct, intentional application; by inadvertent drift into water from adjacent spraying operations; and by leaching of pesticides from treated regions within a watershed (55, p. 120).

A clue to contamination of water resources is given by the great susceptibility of fish to toxic levels of pesticides. Very weak concentrations can be detected by fish. Recently the U.S. Geological Survey, in cooperation with the Environmental Protection Agency (EPA), has been operating a pesticide monitoring network. The most prevalent insecticide was DDT, and the most frequently found herbicide was 2, 4-D. Concentrations of the various pesticides were found to be the strongest in waters that contained appreciable amounts of sediment (55, pp. 120-121).

The major elements found in fertilizers are nitrogen, phosphorus and potassium. Phosphorus compounds have been identified as the key nutrient in causing eutrophication or alga bloom in water resources, though nitrogen and other elements share the responsibility. As the algae die, their decay diminishes the water's oxygen supply, which might lead to suffocation of the fish population. Eutrophication in a less serious form gives water an unpleasant odor and taste (22, p. 43).

Suspended sediment, as previously mentioned, has the property of transporting other materials along with it in a colloidal suspension. An estimated 50 million tons of primary nutrients are carried away by sediment from agricultural and forested land annually (61, p. 24). With phosphorus it has been found that only in areas of extreme erosion does a significant amount enter the water. Nitrates, however, enter into water resources more readily (22, pp. 45-47).

Other chemicals and pH The list of chemicals degrading waters is a lengthy one.[1] If concentrated to a sufficient level any of these chemicals can have an adverse affect on one or more of water's beneficial uses - which includes recreation. Many of the chemicals can affect the acidity (pH) of the water causing damage to aquatic life. Ellis found that an acidity value of 4.0 was toxic to goldfish (as cited in 31, p. 126). However, toxic effects can vary due to other physical, chemical and biological factors. Ideally, for primary contact recreation pH values may range between 6.5 - 8.3, which closely matches the pH value of human's lacrimal fluid (55, p. 144).

Biological substances and the quality of recreational waters compounds

Biological substances that degrade water resources were identified by McKee and Wolf as; (1) sewage and other oxygen demanding wastes, (2) infectious agents, and (3) plant nutrients (31). The plant nutrients of phosphorus and nitrogen were discussed in the previous section.

Sewage and other oxygen demanding wastes includes organic wastes which originate as domestic sewage and as residues from food processing industries. Organic compounds make up about 60 percent of the solid weight in domestic sewage with the remainder being less offensive

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[1]See McKee and Wolf for the listing of potential pollutants (31).

inorganic substances. The major elements of organic wastes include carbon, oxygen, hydrogen, nitrogen, phosphorus and sulfur (15, p. I-66).

When desirable conditions prevail, a plentiful supply of oxygen, organic wastes are oxidized to stable compounds by aerobic respiring bacteria. The oxygen that is used for oxidation is taken from the normally present supply of dissolved oxygen. However, a slower anaerobic bacterial action commences when organic wastes have reduced the dissolved oxygen supply to zero (15, p. I-67). As a result a septic, odorous condition can occur which may hinder recreation opportunities. This reduced dissolved oxygen supply, as mentioned in several sections above, causes a reduction in the kind and quantity of aquatic life.

Infectious agents   Numerous pathogenic entities have been identified in recreational waters that may cause infection in man. The incidence of these pathogens is associated with the presence of sewage. Gloyna categorized the various pathogens that cause waterborne diseases as follows (20, p. 480):

1. Viruses
    a. Poliomyelitis
    b. Infectious hepatitis
    c. Adenovirus - upper respiratory and ocular diseases
    d. Epidemic gastroenteritis
    e. Coxsackle
2. Protozoa
    a. Endomoebic histolytica - amebic dysentery

3. Bacteria

   a. Salmonella - typhoid and paratyphoid

   b. Shigella - dysentery

   c. Spirillum cholera - cholera

   d. Acid - fast bacteria - tuberculosis

Conditions for survival of the pathogens in the water resource depends upon several factors, including exposure to ultraviolet light, degree of dilution, and the physical, chemical, biological properties of the water (15, I-79).

The hazard of these infectious agents is spread to man through recreational swimming or by drinking water supplies. Swimmers can contract illnesses by contact with the mucous membranes, skin contact, inhalation, and ingestion. A study of two fresh-water beaches along Lake Michigan showed that swimmers had twice the incidence of gastrointestinal and ear and throat infections as did non-swimmers (55, p. 47).

Perspective of the physical dimension

There is a vast array of physical qualities found in resources used for water-oriented recreation. The number of materials degrading these resources is a lengthy list. Any material that enters a water resource and is of sufficient concentration can "potentially diminish the beneficial use(s) of that resource" (31, p. 123). When these quality diminishing materials are combined the effect can be greater than their individual impacts, i.e., synergism. This section has surveyed the more important aspects of the physical dimension of water resources with respect to recreational quality. Figure 2.2 illustrates the physical, chemical,

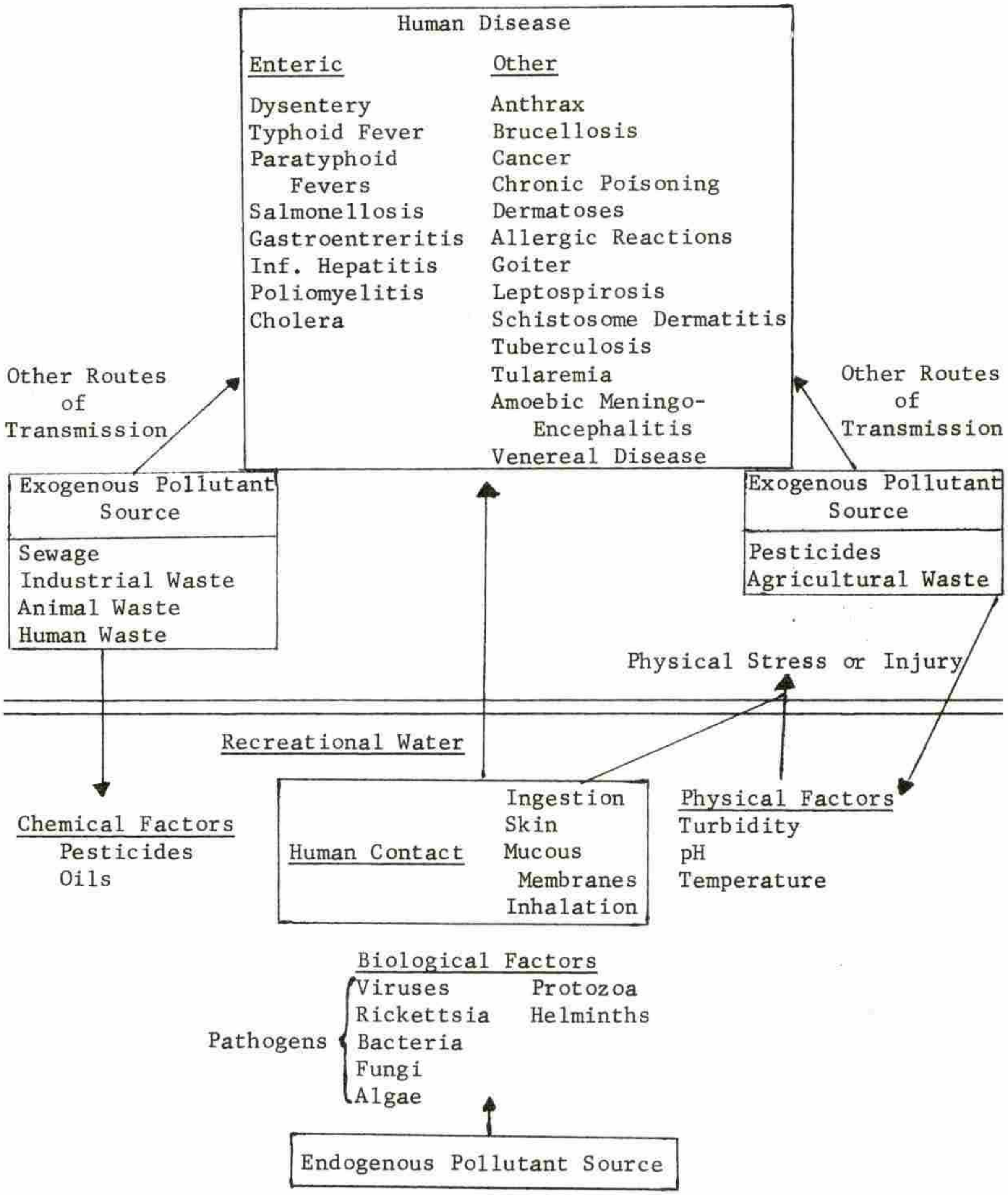

Figure 2.2. Potential recreational water/health hazard relationships (55, p. 9)

biological factors and their relationship to recreational water health hazards that may confront the recreational participant. The type of recreational activity participated in makes a difference in the quality level required, i.e., primary and secondary contact recreation. Also the general susceptibility of the individual to various diseases while participating in lesser quality waters is a factor, i.e., the individual's immunity, tolerance, age, sex, and physical condition.

Analysis of the physical problem is possible. Physical characteristics of quality can be determined, such as concentration of a given chemical in a stream or the amount of soil erosion per acre. Health hazards have been identified, but more research is necessary for further knowledge of health/hazard relationships. Technology offers a wide range of possibilities to ameliorate deteriorated water resource quality. However, to make an efficient choice, the economic consequences of the many possibilities should be considered.

The Economic Dimension

Society is demanding that some natural resources be allocated to outdoor recreational purposes. The goal of environmental quality, which has been placed with the array of other national objectives is closely associated with the outdoor recreational theme. Economics has much to offer in deciding how natural resources, allocated to outdoor recreation, should be used so that they will maximize the net benefits over time for society. Measures to maintain and improve recreational resource quality can be considered as valid benefits to society with respect to the current emphasis on environmental quality. These measures should be analyzed for their economic feasibility since they have varying costs both initially and in the future.

Quality is a major factor in determining the usability of a natural resource for outdoor recreation. Pollutants that degrade recreational water resources, such as sediment and its associated materials, illustrate an important economic phenomenon known as external effects or externalities (43, p. 26). These external effects are the costs and benefits of some economic activities that the market system fails to account for. Benefits or positive externalities from the sedimentation process are the creation of rich valleys and delta regions. Unfortunately, sediment creates unwanted costs or negative externalities, by damaging power turbines, pumping equipment, irrigation systems, and reduction of recreational opportunities in streams and lakes.[1] The discussion that follows is an analysis of the market system and its failure to allocate natural resources to meet recreational resource quality requirements. Welfare economics plays an important role in such an analysis.

<u>The market and recreational resource quality</u>

Demand for outdoor recreation is expected to continue to surge as the population grows, especially in urban areas, along with increases in personal income and leisure time. However, the supply of natural resources that are and can be used for recreational purposes is relatively

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[1]See discussion on sediment in physical dimension of this chapter.

fixed. Complicating the situation is the fact that many of these limited resources are demanded by other uses which are often in conflict with recreational uses and deteriorate the quality. This introduces the fundamental economic problem of allocating limited resources to the many demands for those resources.

At a particular time the resources of an economy are being allocated in a certain arrangement. This is called an economic state. In this economy and in other market-oriented economies the choices regarding the allocation of the limited resources as well as income distribution are mostly guided by the price system. This price system, assuming a competitive market system, operates automatically, constantly adjusting to changes in tastes, income, and resource supplies. It is the chief means of communicating the marginal conditions to the consumers and producers of the economy, i.e., marginal cost = price = marginal benefits. That is, efficient allocation of resources among the different uses refers to the situation in which at the margin the ratio of prices per unit for every pair of goods is equal to the ratio of their marginal resource costs per unit (59, p. 4). However, recreational resource quality, although a desirable "commodity", is not an activity priced by the market system.

In such a system each decision maker, both producer and consumer, tries to maximize his welfare, and by so doing promotes public welfare. The producer attempts to maximize his returns by buying and hiring resources and selling output. A consumer attempts to maximize satisfaction received from spending his income and allocating his time between work and leisure. Although a few outdoor recreational activities are provided through the private market (privately owned campgrounds) and some of the consumer's leisure time is allocated to outdoor recreation, the market fails to allocate resources properly.

If the market for outdoor recreation could be considered to be like the above self-policing private market, then the prices of such a market would lead to Pareto optimality. By Pareto optimality it is meant that the economy is allocating its resources in such a way that production and distribution cannot be reorganized to increase the utility of one or more individuals without decreasing the utility of others (23, p. 255). However, outdoor recreation is typified by external effects. When externalities are present the conditions for Pareto optimality are not satisfied. Hence, the marginal conditions are not met and private costs and benefits will not be equal to social costs and benefits.

<u>Externalities</u>[1] The competitive market system is vast and complex with many functions. Some of these functions it performs well, some not so well, and some not at all (2, p. 99). Allocation of natural resources to outdoor recreation and the attendant qualities desired for outdoor recreational activities fall into the latter two categories, i.e., market failure. Bator defines market failure with respect to allocation theory as:

> ...the failure of a more or less idealized system of price-market institutions to sustain 'desirable' activities or to estop 'undesirable' activities [both consumption and production]. The desirability of an activity, in turn, is evaluated relative to the solution values of some explicit or implied maximum-welfare problem (3, p. 518).

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[1] For elaboration of the economic theory of externalities see Seay (43).

Introduction of external effects create market failure conditions.

Externalities are present whenever an entrepreneurs production function depends in some way on the amounts of the inputs or outputs of others and that the consumer's utility level depends in some way on the amount of consumption of others (21, p. 18).[1] Interdependency of production and utility functions is a property of all externalities. Another property is the lack of compensation. By this it is meant that the one who creates the external cost is not made to pay for it, nor is the one who creates the external benefit completely rewarded for it (2, p. 101).

There are three types of externalities that have been identified by Bator. They are (1) ownership externalities, (2) technical externalities, and (3) public good externalities.[2] All three are present in the outdoor recreational spectrum. For the purpose of examining these externalities outdoor recreational opportunities of a large river with deteriorating water quality due to an increasing sediment load is considered.

The problem of ownership externalities is that of non-appropriability. By this it is meant that the resource user does not bear the full cost or damage of his action. Due to the very nature of the river flowing through various properties (institutional units) an ownership externality is possible. If large amounts of soil erosion occur because of a farming

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[1]External effects need not be ambiguously economies or diseconomies, i.e., positive or negative externalities. It is possible that an increase in an industry's output, resulting in returning more warm water to a river will benefit some uses, like winter navigation, and diminish other uses, such as destruction of aquatic life.

[2]According to Bator these externalities are not mutually exclusive, but rather much externality phenomenon is common to all three types.

operation upstream external costs are created for recreational users downstream. The farmer's marginal private cost for allowing soil erosion to occur is zero, but marginal social cost is positive since swimming and fishing opportunities are reduced.[1] In a free market these external costs are not monetarily priced and the market fails to allocate resources properly to recreational use. Resources will be directed to the good causing the deteriorated quality and few will be directed to the maintenance of recreational water quality. Hence, ownership externalities are basically the result of the inability to define or enforce property rights to a private good clearly enough so that the good can be allocated efficiently by the market (33, p. 1).

Several approaches to solving the ownership externality problem are possible. If both uses are considered to be in the private sector and only two parties are involved then free bargaining is possible. In this situation the harmed party downstream would be compensated by the upstream party who causes the damage, or the downstream user could bribe or compensate the upstream party enough to reduce soil erosion. However, recreation typically involves many users and public good externality characteristics appear. Harmed recreational users will underestimate their harm or cost caused by sediment, i.e., the liars problem. If an effort is made to bribe or compensate the upstream party the recreational

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[1]Although in the long run soil erosion may create costs like reduced crop yields and higher operating expenses, i.e., farming around gulleys.

user will not be willing to contribute his share and let the others pay. His thinking is that he will benefit at the expense of others, i.e., the free rider problem.

Indivisibilities or increasing returns to scale characterize technical externalities. The river can be considered an indivisible source of outdoor water recreation. In addition, there are other sources (lakes) of outdoor water recreation offering similar recreational activities, but some distance away. Sediment has reduced the quality of game fishing on the river. However, if the sediment load was lessened the supply of fishing would be greater than the other recreational areas. Now if equal supply of recreational facilities were available along the river, other things being equal, the river would be more desirable than the other recreational areas farther away. The river then would be considered a principal source of outdoor water recreation. Here is an example of a technical externality, which is basically the result of the indivisibility of supply. According to Davidson, Adams, and Seneca, "...a free market would fail by structure (i.e., because of monopoly pricing) as well as by signal and incentive due to increasing returns to scale and indivisibilities in the production of water-recreational facilities" (10, p. 182).

The final cause of market failure is public good externalities. Public goods differ from private goods in that their use is noncompetitive. By this it is meant that two or more people can use a public good simultaneously without diminishing the supply of the good, i.e., consumption occurs collectively. According to Samuelson the defining characteristic of a pure public good is that "...each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good" (3, p. 531). An example would be a beach along the river which could be used by many for wading and swimming (water quality permitting). Each person would get a certain amount of satisfaction by consuming recreation without diminishing the satisfaction of others. Hence, the individual demand curves for public goods must be added vertically to obtain the total public good demand curve, rather than horizontally as with private goods.

There are two basic kinds of public goods (1) those goods that are produced through technical processes such as lighthouses and national defense, and (2) those goods that are a part of the natural world such as air, water, animal species, and forests (2, p. 126). Outdoor recreational resources fit both categories. Man-made recreational facilities provide numerous recreational activities and nature possesses a wide array of natural phenomenon that gives many recreational opportunities.[1] Regardless of the category in which a public good falls, if it is scarce it will be subject to economic decision.

Quality deterioration of natural resources makes scarce commodities of goods often thought of as "free" goods.[2] Activities that degrade natural resource quality are often termed "public bads", or "negative" public goods, or collective "bads". A noxious odor on a body of water

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[1]The creation of a reservoir provides many water-oriented recreational activities - fishing, swimming, water skiing, sailing, etc. - each of which can be considered a public good.

[2]Scarcity can be thought of in terms of marginal utility. "Endangered species" have a high marginal utility as compared to domestic animals raised for food (2, p. 67).

can reduce the satisfactions of many people participating in recreational activities. Quality degradation of recreational resources can be thought as public bads, but the quality of the resource can be considered a public good. Hence, any attempt to improve or maintain quality by a person or group will benefit others.

Recreational resource quality is often defined as a function of user intensity (7, p. 165). A U.S. Department of Interior report acknowledges recreational quality as "...a value that is inverse to the intensity of use" (58, p. 2). Such a definition exhibits public good characteristics. Most recreational resources appear to possess a user level where additional people in a given resource area cause undesirable crowding. At such a point, the user's recreational satisfaction diminishes with increasing intensity. For instance, one might find an abandoned beach an unsatisfactory experience and seek an area with many. The wilderness camper, on the other hand, would appreciate the absence of other people. In addition, the overcrowding can be both physical and psychological. For example, a campground can be physically full, but recreationists might perceive these conditions tolerable psychologically. Therefore, recreational resource quality can be consumed by people without limiting the 'supply' of quality for others up to a point of congestion. However, due to the collective nature of public goods (recreational resource quality) the consumer who desires better quality can do little. Also no consumer can acquire a quantity of a public good (recreational resource quality) that is exclusively his (23, p. 271).

The market, thus fails to properly allocate resources to public goods. Prices for private goods are determined by the interaction of supply and demand in the market. Public goods cannot be purchased and sold in the market the same way as private goods since there is no effective way of finding the actual demand (23, p. 271). Once a public good is provided many people can share them at no additional cost. In other words, the marginal cost of a pure public good is zero. The aggregate demand curve for public goods requires vertical summation of individual demand curves since the good may be consumed by many consumers simultaneously. Private goods, in contrast, require horizontal summation of individual demand curves to derive the aggregate demand curve because private goods are competitive. If marginal cost pricing is followed the optimum price for a pure public good is zero. It therefore pays people to understate their preferences for such public goods.[1] According to Samuelson, consumers have no incentive to reveal their true (demand) preferences for public goods (39, p. 31). The individual naturally does not feel like supporting a public good since it will be provided by others (probably by a public agency).[2]

Generally, taxation is the best way to finance a public good. If all the users can be identified a tax on each user is most efficient. However, this is seldom the case and a general tax is implemented. Such an allocation is not optimal since some people who would never use the

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[1]The "liars" problem.

[2]The "free rider" problem.

good are paying and others (the users) gain by paying less through the tax than they would be willing to pay. A decision for the production of the public good as well as the tax is a collective decision involving society. Decisions involving society's welfare are made through its various institutions.

The Institutional Dimension

Society considers outdoor recreational resource services and the associated amenities as a desirable commodity. Typically, economic values are created only as people desire things. This desire is reflected by what people are willing to give up and is measured as a price in the market mechanism (7, p. 214). Though there are many benefits as well as costs coming from outdoor recreational activities, there is no such market price to serve as a measure. Indeed, as was seen in the previous economic discussion, recreational resource allocation and its associated qualities possess external effects, especially public good characteristics. If an efficient allocation of recreational resources is desired the "visible hand" of government is warranted.[1] Therefore, institutions are necessarily involved.

Most social choices are made by institutional decision making. That is, the interest of institutions is society's welfare.[2] According to Roberts and Holdren an institution is "...a system of rules applicable to established practices and generally accepted by the members of a

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[1]However, the mere presence of external effects does not necessitate such intervention.

[2]In a dictatorship social welfare could mean the well-being of the dictator.

social system" (38, p. 110). In this country institutions carry out individual and group decisions through a constitution, system of courts, elections, economic structures, and customs of the culture.[1] In the case of allocating natural resources to outdoor recreation it has principally been the role of governmental agencies.

Institutions can either aid or hinder the efficient allocation of resources to recreation. For instance, institutions can constrain the use of a recreational resource by putting an upper limit on its use. This constraint can be set at a level that either protects the resource or allows further quality deterioration of the resource, i.e., setting a limit on visitors in excess of its carrying capacity. Any institution that is involved with recreation resource allocation and the maintenance and improvement of their quality should attempt to understand both the physical and economic dimensions and consider the consequences of decisions made upon society's welfare. Norton acknowledges the importance of institutional knowledge of pertinent economic theory. He states:

> Perhaps the most important challenge to economic theory and its relevance to current problems in society lies in the ability to satisfy meaningful desiderata concerning problems of choice where all social benefits and costs are not reflected by market prices. The decision maker in public office, concerned with the provision of free, public outdoor recreation, is faced with such a situation. He is able through legal and fiscal measures and through public institutions to allocate natural and fiscal resources for the purpose of outdoor recreation (35, p. 416).

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[1]The choices of these represent the overall decision making framework of society or what has been called by Holdren as the Social Choice Mechanism (SCM) (38).

The role of government in outdoor recreation

Pigou thought that people were short-sighted when it came to allocating resources with respect to the future and thus, the state should have a hand in preserving resources for the future. He stated:

> It is the clear duty of government, which is the trustee for future generations as well as for present citizens, to watch over, and if need by, by legislative enactment, to defend the exhaustible natural resources of the country from rash or reckless spoilation (37, pp. 29-30).

There are several arguments for the public provision of outdoor recreational resources (7, pp. 265-271). One that has already been examined is the public nature of outdoor recreation. Like national defense, it is impossible to exclude the benefits from those who do not pay, i.e., the impossibility of exclusion. However, certain recreational activities can be provided by the private market (private campgrounds). If public facilities are available at zero, or a low price, private investment in recreation are destroyed.

Another reason for public provision is the question of scale economies. Often development of recreational resources is extraordinarily large compared to the immediate demand for recreation, i.e., a large reservoir. If effective management, including maintenance of resource quality, is to be accomplished the resource must often be managed as a unit for recreational purposes. In addition, it might be several years before demand for the recreational resource in question is at its capacity. Hence, returns to private investment are often poor. For private investment to be promising high intensity or mass recreation brings greater financial returns, but often at the expense of quality deterioration.

The argument of uncertainty follows. Future forms of recreation might change. Also quicker access to distant recreational areas might be possible, which could eliminate some of the demand for local areas. Although investments involve some degree of risk, recreation might be too high a risk for the private sector to undertake. The government, not a profit seeking entity, can hold large tracts of undeveloped resources for the future.

A final argument to be discussed here is what has been termed the "social externalities in consumption". The argument is that the provision of outdoor recreation is essential to a well-balanced personal life. Those who participate in outdoor recreation become socially better adjusted and better and more productive citizens. Hence, it is to the public benefit to provide outdoor recreational opportunity. This argument, however, has little empirical research to test the assertions that outdoor recreation produces a healthier, socially better, and more productive population. Although if the quality of a recreational resource possesses health hazards to the participants, the public benefit argument may properly be invoked. For instance, if swimmers contract disease while swimming in a recreational area it is to the benefit of the public to eliminate the health hazard. By eliminating the health hazard, and thus the disease from potential carriers, the chances of the virus spreading to the rest of the public are diminished, i.e., society benefits as a whole.

Although the above arguments favor public provision, institutions can mismanage allocation of natural resources to outdoor recreation. Unfortunately, resources are as often allocated in terms of political and economic power as in terms of economic efficiency (2, p. 134). Powerful and influential private companies finance lobbies in the federal and state governments to promote their interests in resource development. Even resources that have been allocated by the government for the express purpose of preserving natural wonders are not safe. A U.S. Department of the Interior report stated that the maintenance of natural wonders in national parks was being jeopardized. It reported:

> ...with the tremendous increase in visitors each year there is a tendency to provide opportunities for mass recreation at the expense of such esthetic values as roadless wilderness, unspoiled lakes protected from the roar of motor boats, the solitude and natural beauty of parks unmarred by mass human activity (58, p. 2).

The role of government will continue and become increasingly important. One reason for this is that the populace is demanding relatively more goods that are of a public nature. This is reflected in pressures for more parks and maintenance and improvement of environmental quality. Secondly, much of potential recreational areas are held by the federal government as public domain. Conflicts will continue to arise over the use of these resources. It will be the job of the government to allocate these resources to the various uses (16, p. 229).

Hopefully, institutions involved with the management of recreational resources and its quality will approach the problem in a multidisciplinary manner. Thus, taking into account the knowledge that can be gained from the numerous disciplines involved in solving the problem.

CHAPTER III. DEVELOPMENT OF THE MODEL

This chapter is devoted to the development of an analytical model that incorporates quality into recreational resource development. Water quality is used as the characteristic of recreational resource quality. The empirical results of the survey concerned with people's preferences of water quality and the effects of improved water quality are discussed in Chapter IV.

In developing the model, methods used for estimating recreational demands are reviewed. Important to these methods and the proposed model is the recreational participant and the experience the participant receives while pursuing recreation, i.e., user satisfaction. It is the participant who demands that some natural resources be allocated to outdoor recreation; who benefits from these recreational resources; and who perceives the quality of recreational resources.

Essentially it is the recreational participant that links together the three dimensions of recreational resource quality discussed in Chapter II. There is a certain resource quality that most people prefer. If it is absent the satisfaction of the person participating in the recreational activity will decline. Economics can aid in selecting the best of several technological possibilities of improving and maintaining resource quality that the participant prefers. The participant's interest in resources used for recreation and their corresponding quality can lead to institutional action. Institutions should be able to react to public demands for protecting recreational resource quality by the proper legislation and administration.

The Economic Framework

Not until recently have recreational services been recognized as products of land and water resource use (26, p. 125). As was described in Chapter II valuation of recreational resources and their attendant qualities provides a formidable problem for economic analysis. Benefits are hard to determine because most recreational resources are either not priced in the market or only partially priced through charges that are usually not set by market conditions. Recreation may be outside the market mechanism, but it is nonetheless, an economic process with production and consumption and not outside the framework of economics. Although many efforts to measure outdoor recreational benefits appear in the literature, no completely satisfactory method has yet been developed.

A currently popular method of evaluating public projects, such as dams and other water resource improvements, is benefit-cost analysis. Recreational benefits often are a principal portion of the total benefits attributable to a particular project. However, benefit-cost analysis is not without problems when it is applied to public investments. According to Maass:

> The major limitation of benefit-cost analysis, as it has been applied to public investments in the United States is that it ranks projects and programs in terms only of economic efficiency. (At the national level this means that projects and programs are judged by the amount that they increase the national product.) But the objective of most public programs is not simply, not even principally, economic efficiency (30, pp. 311-312).

Indeed most public projects have more than one objective function. Environmental quality, which has recently become a national objective was long neglected in project considerations.[1] The wealth of literature over the past forty years on benefit-cost analysis for water resource development has said virtually nothing about environmental quality. Where public projects despoiled natural environments the "extra-economic" considerations of resource quality were noted only in passing (17, p. 19). For instance, reservoir projects provide benefits from still water, but they simultaneously pre-empt the scenic and recreational benefits of a free-flowing river (45, p. 1).[2] Also land economic texts say little about the economic issues involved in the allocation of wildlands and scenic resources, nor do the costs of land development include the opportunity returns foregone as a result of destruction of natural areas (17, p. 19). Recent work done by Seay (43) and Jacobs (25) indicated how benefits could be quantified from improved water quality levels, but did not estimate the aesthetic benefits of improved water quality. Much of the same is evident in the statistics of outdoor recreational demands. Quantity factors, such as amount of recreation acreage and number of visits, seem to prevail. Such an emphasis on quantity gives the impression that outdoor recreational quality is ignored. Such an exclusion from evaluation of recreational benefits is unwarranted.

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[1]The National Environment Policy Act of 1969, requires that an environmental impact statement be prepared for all public projects.

[2]See Krutilla, of Resources for the Future, regarding the Hell's Canyon controversy (27).

The following section delves into the benefits or values of recreation and reviews some of the predominant methods of measuring or estimating these benefits. There seems to be general agreement on utility or user satisfaction as the basic concept of recreational resource value and that the user's willingness to pay is the measure of utility (45, p. 1).[1] It is this willingness-to-pay on the part of the recreational user that creates values for recreation resources. It is seen that user satisfactions (and dissatisfactions) of the participant's recreational experience are closely related to recreational resource quality.

The Evaluation of Recreational Benefits

Normally, in economic analysis, it is assumed that the consumer maximizes his utility function,

$$U = U(Q_i \ldots Q_n)$$

which is subject to the income constraint,

$$I = p_i Q_i + \ldots + p_n Q_n$$

where Q_i are the goods purchased at prices p_i from a given income I. In other words, the consumer desires to purchase a combination of goods that will give him the highest level of satisfaction with his limited budget or income.[2] From the solution of utility maximization a general demand function for a particular good, k, can be obtained. The quantity demanded of this good is a function of the prices of other goods and of course income. The function is represented by,

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[1]Utility is very difficult to measure.

[2]Theory of consumer choice.

$$Q_k = f(p_i \ldots p_k \ldots p_n, I)$$

Benefits from a good or service are understood to be the amount of money spent on them. Usually these are called primary benefits. These initial expenditures result in multiplier effects creating secondary benefits. However, recreation is unusual because market prices are absent making demands for recreation services difficult to measure. In such a system the "extra market" primary benefits of recreation would be zero (41, p. 6).

Recreational benefits are those values that accrue to the recreationalist as a result of participating in a recreational activity, i.e., the recreational experience (41, pp. 5-6).[1] This kind are termed primary benefits, or direct benefits.[2] Primary benefits are generally taken to be expressions of the consumers' willingness-to-pay for recreational services and can only be attributed to the site or facility where the experience is undertaken. According to Knetsch and Davis, "These values may or may not effect the commerce of the region or the region or the commerce of the nation. When appropriately measured, they are useful for guiding social choices at the national level" (26, p. 127). Benefits that are the result of local monetary expenditures of recreationists, and the resulting multiplier effects, are termed secondary benefits, or

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[1]According to Clawson, the total recreation experience is more than the actual outdoor recreation activity at the site. He believes that the total recreation experience encompasses more, and divides the experience into five distinct phases. They are, (1) anticipation and planning of the trip, (2) travel to the area, (3) the on-site experience, (4) returning home, and (5) recollection of the recreation-experience. For a discussion of the total recreation experience see: Clawson and Knetsch (7, p. 33).

[2]Also known as national benefits.

indirect benefits.[1] These expenditures include costs for traveling, lodging, equipment, and so forth (26, p. 128). This section is concerned with primary benefits.

As the demand for outdoor recreation continues to grow as well as the general demands of other uses for natural resources, the desirability of establishing values for recreation use for the natural resources becomes increasingly important. A number of methods for measuring or estimating recreational benefits have been proposed and to some extent used. According to Knetsch and Davis, "Some of the measures are clearly incorrect; others attempt to measure appropriate values, but fall short on empirical grounds" (26, p. 129).[2]

Benefits equal expenditures This method is also termed gross expenditures which attempts to measure recreation benefits by the total volume of user expenditures on goods and services related to recreation. Such expenditures include travel costs to the recreational area, equipment purchases, and expenses incurred when at the recreation site. This method generates large figures for benefits. Proponents of this method believe that the value of a day's recreation is comparable to the personal monetary expenditures of pursuing that day of recreation.

There are several weaknesses to this method, and thus it is a poor method for justifying a recreational project. Primary benefits cannot be measured properly by expenditures since this would ignore the benefits which go to persons that spend little or none (46, p. 64). Also many

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[1]Also known as local benefits.

[2]A good introduction to evaluation of recreation benefits is found in Knetsch and Davis (26), from which many of the methods reviewed here are taken.

of the expenditures counted in this method do not represent primary benefits, but instead are secondary benefits. For instance, money spent on lodging in the area of the recreation project, though increasing the net income of the area, is not a direct benefit project. Another weakness is the fact that if the recreational area involved were to be removed consumers would likely continue to consume recreation, but at other areas, i.e., second choices. It is this loss that represents the value of a particular area. Hence, it is not the gross value of expenditures, but rather the net increase in value over and above what would occur in the absence of a particular recreation opportunity (26, p. 129).

Benefits equal recreation resource costs The assumption of this method is that the value of a recreational resource is equal to or some multiple of the costs of creating it. By implementing this method any planned project becomes justifiable in terms of recreational benefits alone. The criterion of a benefit-cost ratio of at least one is automatically accomplished.[1] According to Knetsch and Davis, this "...method offers no guide in the case of contemplated loss of recreation opportunities, and allows little or no discrimination between relative values of alternative additions" (26, p. 129).

Benefits equal market value There are several methods in this classification. Common to them is the imputation of recreation benefits with some market price. These prices are multiplied by actual or expected attendance figures to reach a value for the recreational activities.

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[1]It has been the rule that in order for public funds to be invested into a project, benefits must be equal to or exceed the project costs.

One technique is to value the benefits of fishing and hunting with the market value of similar species of fish and game sold commercially (9, p. 58). This method fails in considering only fishing and hunting as the specific objectives of the recreational activity. Also many of the hunted species of fish and game are not available on the commercial market. Even if they were available in the market, the fishing and hunting costs might be in excess of the market price. Although this does indicate that the fisherman and hunter are willing to incur expenses to make the choice of fishing and hunting.

Similarly, benefits of fishing have been equated with the price charged for sport fishing by a private fishing establishment.[1] Unfortunately, private and public recreation areas differ substantially, and thus are not fully comparable. Private areas usually charge higher user fees, are closer to population centers, and offer different qualities than public recreation areas. It is, therefore, inappropriate to evaluate the benefits of public recreation areas by using the prices charged for the different product of private recreation.

Benefits equal willingness to pay   Primary benefits, important in evaluating recreational benefits of projects, were defined earlier as the consumer's willingness to pay for recreational service. It would be ideal if it were possible to measure this willingness-to-pay for outdoor recreation services as though the consumer was paying for it in the market system. The willingness-to-pay for a given amount and quality of outdoor recreation of all consumers is represented by the area under the demand

[1]Charges for hunting in private hunting preserves would also qualify.

curve. This area is what the methods seek in measuring. Two methods based on willingness-to-pay principle are discussed here. They are the interview methods and the travel-cost methods.

Interview methods The basis of the interview method is to ask consumers the maximum price they would be willing to pay in order to avoid the loss of using a particular area (26, p. 131). Since most recreational services are provided as public goods, and therefore, at zero or low prices, the interview provides a method for discovering the price of the recreational opportunity if it were marketed. The benefits of the recreational opportunity are the sum of the responses given by the interviewed. Essentially this is the value of the area under the demand curve for the recreational opportunity in question, i.e., consumer surplus. However, due to the public good nature of many recreation resources, values obtained by this method are subject to possible bias.

The main bias of the interview method is that when interviewed, the consumer of a public good will give a faulty response to his preference for the good. He will either understate or overstate his preferences for the good. In the case of understatement the consumer avoids paying the full amount he would actually be willing to pay for the good he knows will be provided. Knetsch and Davis argue that this might be a false point. They feel that the recreationist is aware that both private and public recreation providers can invoke their respective powers and limit access to those completely unwilling to pay their share (26, p. 132). In overstating his preferences for the provision of a recreational resource the consumer may think he is helping to build a case for its establishment.

Important in this method is the careful planning of interview questions. It has been found that the less hypothetical the questions, the more reliable are the responses. In practice the person might act differently than how he responded. Preferably the interview will be given to a population that is aware of the problem being questioned. Such knowledge by the interviewed lends stability to interview results. There is always the possibility that the interviewer will confuse or bias the person being interviewed. Also the person interviewed may feel rushed and not respond thoughtfully. In addition, interviews are expensive. One way to reduce these expenses is the use of mail questionnaires. This technique suffers in that many questionnaires are never returned.

In spite of the several drawbacks, interview methods are correctly directed to measuring willingness-to-pay. The interview method affords a good way of finding recreationists' preferences of recreational resource qualities. If an interview registers recreationists' appreciation for maintenance and/or improvement of resource quality, then it can be said that there is some value in preserving quality. Knetsch and Davis believe "...that something exists to be measured, and is sufficiently real and stable phenomenon that the measurement is useful" (26, p. 132).

Travel-cost method   The travel-cost method is an alternative approach of measuring the willingness-to-pay of the recreational consumer. This method uses travel-cost data, like costs per distance, as a proxy for price of the non-market benefits from a recreation resource. From the prices obtained, demand schedules can be constructed and consumer surplus calculated from the area under the demand curve.

Using distance to arrive at a monetary value for recreational resource benefits was first suggested by Hotelling in response to a 1947 National Park Service questionnaire. Hotelling divided the area around a recreational facility into concentric rings or zones. Those people residing in a particular zone would all incur approximately the same travel costs if they were to visit the park facility. People living in distant zones would pay higher prices for visiting the facility, whereas those people living near the park would obtain a bargain price for a visit, i.e., a consumers' surplus exists which equals the differences between the most distant user and those living closer (2, 45, 41).

In the decade following several attempts at using Hotelling's indirect approach were made. Most notable of these were Trice and Wood (53), and Clawson (4). Both of these studies assumed, as in Hotelling's original model, that the quantity or recreational use (Q_r) in a particular activity was solely determined by travel cost (p) (45, p. 5). Hence,

$$Q_r = f(p)$$

Clawson, however, went further by developing a demand curve for the whole recreational experience (6). To accomplish this two steps were involved. First, was the derivation of a visitation-prediction model. Visitation from a particular zone to the recreational site was a function of travel cost by automobile. The zones represented costs per distance, and hence, the number of visits per unit of total population of each zone would be different. Population in each zone was considered to be homogeneous with respect to recreation attributes and demand. From this, visits per unit of population could be plotted against the cost per visit.

The second aspect was the construction of a demand curve for the particular recreation site. This demand curve was basically derived from the visitation-prediction equation by relating visit rates of each zone to simulated increases in entrance fee cost and multiplying by the relative populations in each zone. The costs, representing higher travel costs, were increased until total visitation to the recreation site approached zero. From these results the demand curve was constructed relating price to visits to the recreation site. The area under the demand curve measured the value of consumers' surplus.

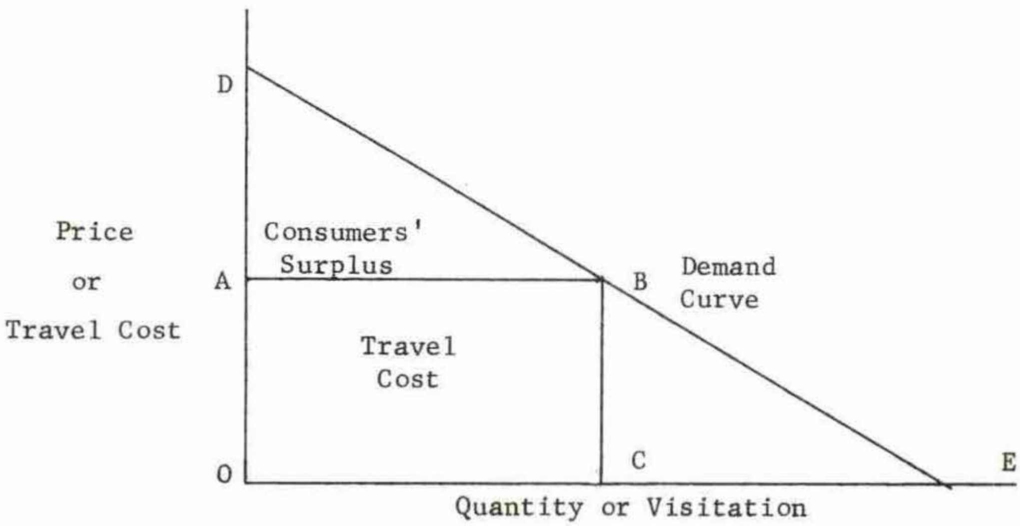

Figure 3.1. The Clawson 'demand curve'

Figure 3.1 portrays the Clawson 'demand curve'. When travel costs, including a hypothetical one dollar entrance fee, are represented by OA the quantity demanded or number of visits to the recreation area is OC. The rectangle OABC represents all travel expenses. Triangle ABD is the amount of consumer surplus that can be associated with the site.

According to Knetsch and Davis, instead of using "...visits as a simple function of cost, in principle there is no difficulty in extending the analysis to other factors important in recreation demand, such as alternative sites available, the inherent attractiveness of the area in question or at least its characteristics in this regard, and possibly even some measure of congestion" (26, p. 139).

Several economists have challenged Clawson's demand curve method. Pearse (36) eliminated the doubtful assumption of each zone having homogeneous populations by dividing the visitor population into several income groups. The user with the highest travel cost in each group was selected and considered the marginal user. By this it is meant that if costs were increased this user would forego further recreation activity. Consumers' surplus was calculated by finding the difference between each visitor's travel costs to the zone and the value given as the highest travel costs. Essentially, all Pearse did was to change the emphasis from distance to income, and by so doing assumes that members of each income group have similar indifference maps for recreation. Also the questionable assumptions that are inherent in consumers' surplus remain.

Other modifications in the travel-cost procedure have occurred. Brown, Singh, and Castle introduced income (I) and distance (D) supplement travel costs as variables to predict use (45, p. 3). Another change to the demand model was the inclusion of recreation resource quality (E). With these additions the demand model for recreation became,

$$Q_r = f(p, I, D, E)$$

Empirical regression functions were carried out from observations on Q_r, p, I, D, and E. Benefit values were calculated by determining the area under the demand curve which was constructed by varying price and holding I, D, and E constant. Again the assumption is made of a homogeneous population - which reacts the same way to recreation characteristics, i.e., tastes are constant or not significant determinants of use (45, p. 6).

Alternative recreation activities were included in the demand models by Boyet and Tolbey, and Burt and Brewer which partially incorporated the concept of tastes.[1] The amount of use of each recreation activity was measured in terms of non-days or hours. The demand equation became,

$$Q_r = f(p, I, D, E, V_i \ldots V_n)$$

where the subscript to the activity character V, measures the marginal rate of substitution of activity V_i for the dependent variable Q_r.

Recent research by Sinden (45) attempts to include the effect of taste and intensity of preference into the demand model. This is accomplished by finding the intensity of preference a user has for one environment over a base environment, i.e., differences in recreation resource qualities. Implied in this model is that the quantity demanded of recreational area varies directly with the intensity (T) of recreational satisfaction or expected utility. The demand equation is,

$$Q_r = f(p, I, D, E, V_i \ldots V_n, T)$$

Now both travel costs and preferences enter into the determination of choices. Preference orderings of indifference curves are tools to

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[1]See Sinden (45).

estimate benefits, i.e., benefit evaluation can be obtained from direct estimates of individual utilities instead of the indirect estimates of aggregate utilities (45, p. 8).

Another fairly recent development to the travel-cost technique is that of Norton, who avoids the subject of consumers' surplus altogether. He believes that recreational benefits from a site can simply be obtained by summing the total travel costs incurred by all the visitors to reach the site. Norton states, "The cost of travel to an area is regarded as a threshold expenditure that has to be made before any recreation can be enjoyed in that area" (35, p. 417). This value is comparable with the total revenue of a product priced in the market. Recreationists, like the market consumer, choose the areas and carry out recreation activities that give them the most satisfaction. The user, with a limited budget, makes these choices knowing that travel costs will be different for the various recreation areas, i.e., location.

Benefits unlikely to be measured The methods discussed thus far have been primarily concerned with the measurement of effective demand in the current time period and possibly to predict future effective demand. However, there are two other closely related demands that can be considered. These are the demand created by the opportunity effect and option demand. Both of these demands are not likely to be measured to any degree of accuracy by existing methods since they will seldom become effective demands.

The demand generated by what has been termed the opportunity effect results from an improvement in recreational resource qualities and/or the development of new recreation areas. If recreational facilities are not available people will tend not to participate. Also a person who has not participated in recreation will not know the possible enjoyment obtained from outdoor recreation. Without a convenient recreation facility people will have little chance to develop the skills required for some outdoor recreational activities, i.e., water skiing. Once a facility is constructed and/or people become acquainted with outdoor recreational activities demand will grow for facilities. As more people in the present participate in a certain recreational activity future demand is stimulated without diminishing the presently available supply. As Davidson, Adams, and Seneca point out that "...sufficient present demand for the facilities in question may be the only way a future source of supply can be assured" (10, p. 186). In a Michigan survey it was found that as the quantity and the quality (to some extent) of recreational facilities increases, the number of non-participants who have no desire to go fishing in the future declines (10, p. 185). In other words, some non-participants exercise their option demand and become participants.

Option demand is when a non-participant, who might have no desire to become a participant in the future, may be willing to pay to preserve natural resource. People may want to act in this manner so as future generations may have the opportunity to see the resource in question or possibly "just knowing" the resource is there in a preserved state may be enough for some people to exercise their option demand.

Both demand derived from the opportunity effect and option demand possess public good characteristics. The opportunity effect by increasing future demands implies that the present demand enters into the utility function of future consumers without reducing the future supply of the resource. In the case of option demand many people can enjoy the option of preserving the quality of a recreational resource, although not having to finance this option, i.e., the free rider.

The Model

In building a model the previous material was important. Recreation and the attendant resource qualities is one of the major demand categories of society. However, empirical measurement of the benefits of recreational resource quality is very difficult. If society wishes to efficiently allocate resources for maintaining and improving the quality of recreation resources some idea of the public's demand for the quality would help in allocation.

Important in any model that attempts to measure the social benefits from improving natural resource quality is consideration of the consumer. The consumer of recreation divides his time between work and leisure; his income between consuming various goods and services. Recreation uses some of the consumer's leisure time and can be considered a consumptive good. Allocation of the consumer's time and income is done so that utility is maximized. Recreational resource quality contributes to the user's satisfaction or utility.[1] In terms of the Roberts-Holdren (38) social process theory a consumer has a set of drives which are biological, psychological, and economical that he or she continually tries to reduce or satisfy, i.e., maximizes drive reduction. It is assumed in this study that the knowledgable recreation participant would prefer better quality over lesser quality in his or her recreation experience, i.e., the participant maximizes utility and/or drive reduction. Hence, when the quality of recreation resources is below desired quality levels a social cost is registered in terms of recreation foregone.

What remains to be done is to determine empirical estimates of the benefits from an improvement in the quality of recreation resources. The assumption is made that the amount of recreation participation varies directly with the improvement in the quality of recreation resources - as water quality improves, the intensity of recreational use increases. This relationship is shown in Figure 3.2 (three dimensional).

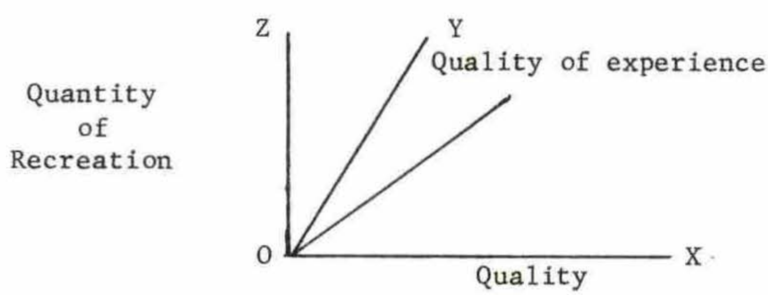

Figure 3.2. Relationship of improved recreational resource quality to the quantity of recreation demanded and associated quality of experience

[1]See Stevens (49), who tried to estimate direct recreational benefits from water quality control by using market demand curves for a sport fishery. Quality was quantified by assuming the quantity of fish caught was influenced by water quality. Quality was measured in units of "angling success per unit of angling effort".

Some sort of monetary measure is desirable in determining the benefits on improvement in the quality of recreation resources. These benefits can be compared with the costs of reducing quality deteriorating materials from a recreational resource. The question of the public's willingness-to-pay for improving recreational resource quality can be answered by using interview techniques. Though the amount obtained might not be fully reliable, it does however give some measure of the importance of the quality of recreation resources.

Application of the model was performed in a central Iowa region. Data was collected from a personal interview questionnaire. This questionnaire attempted to evaluate the public's attitudes on natural resource services such as wildlife, forests and free-flowing streams that would be preserved in a green-belt recreation facility along the Skunk River between Ames, Iowa, and Story City, Iowa, were established. The design of the survey is discussed and the empirical results are presented in the next chapter.

CHAPTER IV. APPLICATION OF MODEL AND EMPIRICAL RESULTS

This chapter includes the application of the model to the study area. The empirical results from the survey which attempted to discern social benefits from an improvement in water resources used for recreation purposes are presented. Benefits from improved water quality are reflected in increased outdoor recreation demand.

There are two major sections to this chapter. The first section includes; a description of the study area, the design of the survey used in this study, and questionnaire preparation. The second section presents the empirical results, which includes the population characteristics of the survey's sample, statistical results of responses given to questionnaire including estimates of additional recreation participation, and additional willingness-to-pay when water quality is improved, and a discussion of the significance of the results with respect to recreational resource quality. Chapter V follows, which comprises summary conclusions, and limitations of the study.

Study Region, Survey Design, and Data Collection

General physical description of study region

The area selected for application of the model described in the previous chapter is the upper Skunk River basin at the site of the proposed Ames Reservoir, near Ames, Iowa. Located between Ames, Iowa and Story City, Iowa, the Skunk River meanders narrowly through a scenic, mainly deciduous native forest (Figure 4.1). Below Ames, the Skunk River

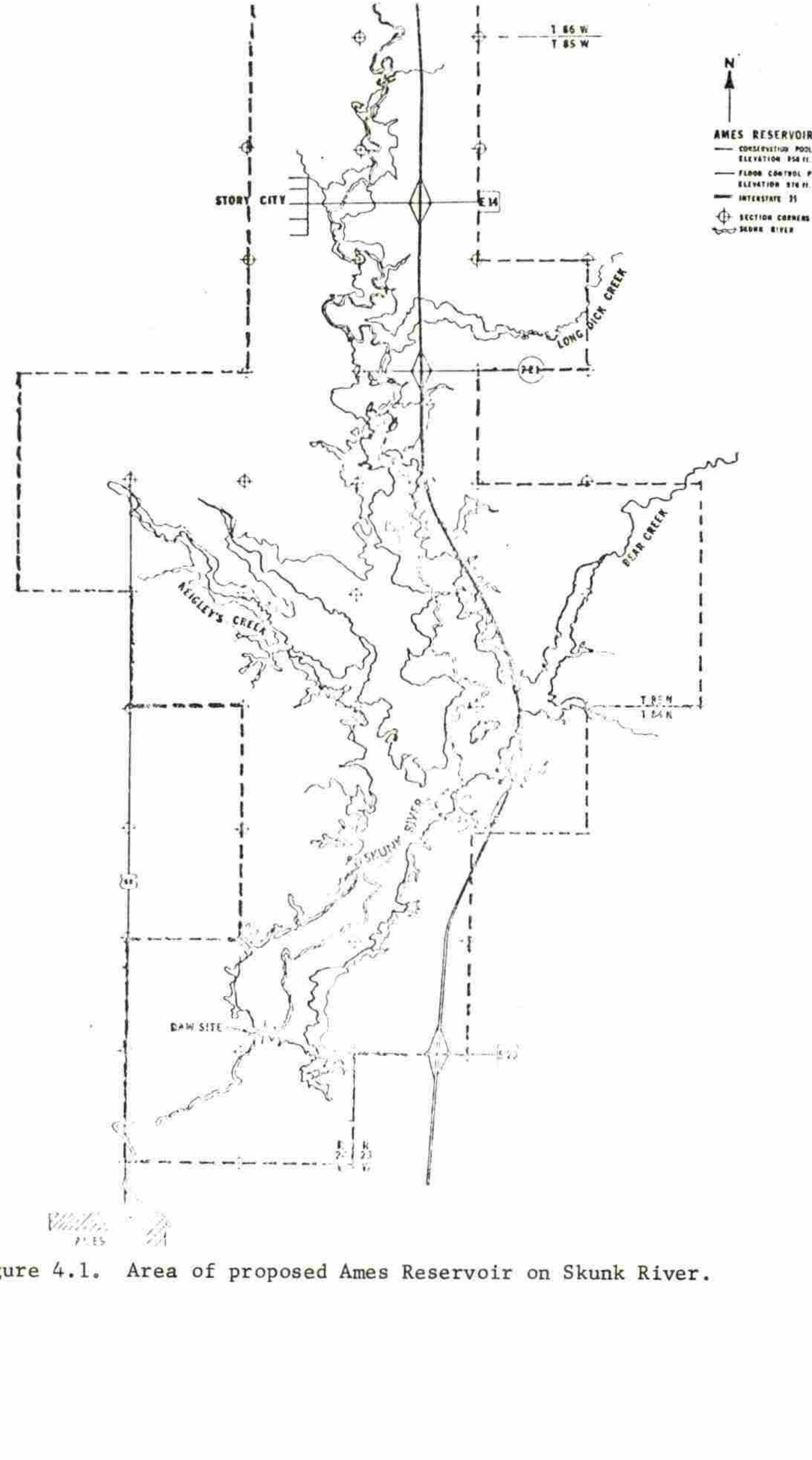

Figure 4.1. Area of proposed Ames Reservoir on Skunk River.

shows significant contrast to the reach above Ames. Here the river has been straightened by channelization with the bordering forest often replaced by cropland. If the proposed reservoir is built, many acres of natural resources that provide various outdoor recreational services will be foregone.[1] These services, termed amenities are the subject of a present study by Schellenberg (42). An alternative to the reservoir development proposals is a green-belt recreational facility which would preserve the natural quality of the area.

The upper Skunk River basin in this area, due to the most recent glaciation, is characterized by flat prairies and shallow valleys which have been almost entirely placed in the production of agricultural crops. The valleys have very little alluvium and associated ground water to sustain dry-weather flow in this segment of the Skunk River (24, p. 5-5-3). Major tributaries to the Skunk River in this region are Keigley's Creek, Bear Creek, and Long Dick Creek. During low-flow periods effluents from various municipalities make a desirable physical contribution to the river's aquatic life. Towns above Ames include Ellsworth, Jewell, Roland, and Story City. However, the quality levels of these effluents are important.

Deterioration of the Skunk River in the area of concern comes from both municipal waste water discharges and land runoff. During dry periods of little surface runoff many of the quality deterioration

[1]Natural resource categories in the proposed Ames Reservoir region listed by Schellenberg (42), include wooded parks, prairie relics, prairie potholes, forests, wooded pastures, wildlife habitat, and free-flowing streams.

materials come from the municipal sources. Whereas, during periods of rainfall and surface runoff most of the quality deteriorating materials are due to land runoff (24, p. 5-4-21).[1]

No matter what kind of recreation facility is finally adopted and constructed in the area, water quality will be an important element. According to Baumann and Dougal (as cited in 24) waste water treatment at Story City must be expanded whether or not the reservoir is built to preserve the existing aquatic life in the stream or control the total coliform bacteria discharged into the reservoir (24, p. 5-4-39). The "murky" brownish color of the Skunk River is due in part to suspended sediment that is typical of many Iowa rivers. Esthetically, cloudy waters of a reservoir or free-flowing stream are unappealing for recreation use. As mentioned in Chapter II sediment can fill reservoirs up, thus reducing the expected lifetime, and limit aquatic life by lowering the dissolved oxygen level. Suspended sediment principally comes from runoff from land used agriculturally.

<u>Estimation of suspended sediment in the Skunk River above Ames</u> Although there is a suspended sediment load in the Skunk River it is quite low compared with other Iowa rivers. One study by Shobe (44) measured turbidity levels in the Skunk River above Ames. The range was from 10 J.T.U. to 95 J.T.U. (44, p. 35).[2] It was assumed for this study that turbidity and suspended sediment were the same, although in reality

[1]See Baumann and Dougal (as cited in 24) for data on water quality parometers between Story City and Ames taken April-October 1972.

[2]Jackson Turbidity Units, defined in Chapter II.

they are not. Using a conversion factor of 100 JTU = 150 mg/l of suspended sediment the above range can be translated giving 15 mg/l to nearly 150 mg/l (43, p. 76). This range is partially below the figure of 37.5 mg/l level that has been developed for aesthetics and primary contact recreation (56, pp. 3-4). The level of 75 mg/l which is used for warm water fish habitat includes more of the above range (56, p. 34). Unfortunately, other Iowa rivers do not all have such desirable low suspended sediment rates. For example, the Nisnabotna River in the southwestern part of the state has had a high level of 17,800 mg/l (43, p. 142). Indeed, if water quality is shown to be a significant factor determining recreation demand in the Skunk River area, consideration should be given for improving the quality of the Skunk River as well as those rivers heavily ladened with suspended sediment.

Survey design

In Chapter III it was stated that the best way to obtain the public's preferences for quality of water resources was to consult them directly. Some idea of the benefits coming from an improvement in water quality can be gleaned from finding the public's change in visitation to an area after better water quality is evident and their willingness-to-pay for this betterment of water quality. To accomplish this it was thought that the willingness-to-pay method of personal interviews was appropriate.[1]

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[1]As discussed in the previous chapter mail questionnaires are less expensive than personal interviews, but the percentage returned in the mail is also less.

At the time of this study's inception, Schellenberg (42) was designing a public survey to obtain information on the public's preferences for natural resource amenities located in the proposed Ames Reservoir area and their willingness-to-pay to visit the reservoir alternative of a green-belt recreation facility. The opportunity of adding pertinent questions to Schellenberg's questionnaire, and thus fulfilling some of this study's objectives was made possible by Professor Timmons' encouragement for a joint effort and Schellenberg's generous cooperation. The following section describing survey procedures to procure the desired information from the public, though not intentional, but rather because many aspects of the survey were the same, is similar to a comparable section in Schellenberg's study (42).

Selection of sample   A rather large geographical area was selected for the survey. A nine county contiguous region in central Iowa was chosen which was the same one used for the Ames Reservoir Environmental Study (ARES).[1] These nine counties include rural, small and large towns, and metropolitan areas all within a 50 mile radius of the proposed Ames Reservoir.[2] This distance was thought to be great enough to be a factor in people's decisions to participate or not to participate, i.e., willingness-to-drive if better quality was available.

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[1]Appendix 5 of ARES is a project review for an environmental impact statement to be prepared by the Corps of Engineers for compliance with the National Environmental Policy Act of 1969 (24).

[2]Counties include: Webster, Hamilton, Hardin, Boone, Story, Marshall, Dallas, Polk, and Jasper.

The population of the central Iowa study region was 567,000 in 1970 (24, p. 5-1-60). Of this population metropolitan Des Moines represents a significant proportion, about 50 percent. Since the total sample to be drawn was of only moderate size any sample drawing on the basis of proportional population would contain around 50 percent of the responses from the Des Moines area. To rectify this an inner and outer stratum were created.[1] The inner stratum included the population in Story County and some townships in adjoining counties or approximately a 15 mile radius around Ames. The remaining portion of the nine county region was classified as the outer stratum.

Due to the rather large sample area it was decided that only one person respond per household, i.e., the respondent. Certain respondent qualifications were established during survey development.[2] Only the head or spouse of the family were interviewed since it was felt they would indicate family preferences best. Additionally, no persons under the age of eighteen were to be interviewed. Normally, it was expected that more females would be home, and thus interviewed. To account for this possible disproportionality the populations of each stratum were divided in half by sexes. Only males would be interviewed in one half and only females in the other half. See Survey sample prepared by Harold Baker of the Statistical Laboratory in Appendix C.

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[1]Des Moines it was felt could be safely represented by a lower percentage, Survey results were around 24 percent.

[2]The Iowa State University Statistical laboratory performed a key role in designing the survey, drawing the sample population, preparing the questionnaire, collecting data, and analyzing the survey results.

Questionnaire preparation The principal means of obtaining the desired information so that benefits might be derived was through the use of a questionnaire. Wording the questions in an understandable way was most important. Any attempt to express degrees of natural resource qualities without using technical characteristics was extremely difficult. However, if technical language were used the respondent in many cases would be confused. It was felt that this difficulty in defining quality could be compounded by each respondent's differing perception of resource qualities. Due to the difficulty and the exploratory nature of the topic in general, it was decided to word the questions non-technically so that some indication of the public's awareness of the present Skunk River water quality situation and their appreciation for "cleaner" water could be obtained.

As mentioned before this study's questions were included in Schellenberg's questionnaire. With these additional questions the interview time, usually running less than 45 minutes, was still reasonable. Questions were directed toward the reservoir alternative of a green-belt recreation facility. The whole questionnaire included four sections. Only two sections, I and IV, are relevant to the purposes of this study. These sections are the content of Appendix A. Sections II and III are concerned with describing the green-belt facility and obtaining people's preferences of the natural resource categories that would be saved if the green-belt facility were established. For further discussion see Schellenberg (42).

1. Section I   This section's purpose was to document certain household characteristics that were hypothesized to influence the responses. Such characteristics as age, education, occupation of the household head, years lived at the present address, and years the household head had resided in Iowa. Also the kind of residency that the respondent had lived in for one-half of his or her life, i.e., farm, rural, non-farm, city of population under 10,000, city of population over 10,000, and none of these. Residency and the kind of residency, it was believed, might influence the respondent's answer.

Other information included number of people in household and household income. Income, which can be a "touchy" question, was left until the end of the questionnaire so as not to offend the respondent. Although not indicated on the questionnaire, distances to the site of the proposed Ames Reservoir were calculated by using maps in the Statistical Laboratory, i.e., Soper's Mill was used as a reference point.

2. Section IV   This section's emphasis was on willingness-to-visit and willingness-to-pay aspects of the household or the GNP maximizing criterion. Question 9(a), (b), (c), (d), beginning this section, queried the respondent on his willingness-to-visit the green-belt facility, reasons why the household would participate at the area, and the household's willingness-to-aid financially to the establishment of said facility respectively. The questions that followed pertained to the goals of this study.

Questions 10(a) and 10(b) were designed to obtain some indication of the public's appreciation and awareness of the water quality in the Skunk River. Some bias may have been introduced here by the fact that when the respondent was asked these questions he or she may have been thinking of other bodies of water which had differing degrees of quality. Certainly the respondent's knowledge of water quality degradation was a factor in his or her perception of present conditions. However, it was possible that the respondent was ill-informed and could not reliably answer these questions. In such cases the respondent was able to answer "don't know". If the respondent answered 10(a), no and 10(b), yes, the interviewer was informed to skip to question 11 as questions 10(c) and 10(d) would have no meaning.

Questions 10(c) and 10(d), similar in nature to questions 9(a) and 9(d), sought the household's willingness-to-visit the green-belt facility if water quality improved and willingness-to-aid financially for water quality improvement in the green belt area. For these questions (10c, d) the respondent was asked additional days per year the household would visit and the additional dollars per year it would spend over the amounts given in questions 9(a) and 9(d) when water quality improved.

Bias was again expected in these questions for much of the same reasons given by Schellenberg (42) for questions 9(a) and 9(d). It should be stressed again that respondents were directed to thinking about the green-belt facility. Any optimism the respondent indicated for said facility could certainly carry over to their responses given to the questions concerning water resource quality. Also it has been shown that people when given the chance to evaluate a person tend to over rate. This fact could be reflected in the respondent attempting to answer the questions in a way as to please the interviewer. Another factor causing bias was the public good characteristics of improving qualities of recreation resources. As mentioned in Chapter II if the quality of the environment were improved, all could enjoy it without paying the full amount they might be willing-to-pay for it. Thus, it would be to the respondent's advantage to understate the actual amount he or she would be willing to spend for water quality improvement. However, the opposite can be the case. If the respondent wants better quality in the recreational experience he or she might overstate the number of visits and the amount willing-to-spend in order that better quality does occur. It should be noted that the willingness-to-visit is an indication of the respondent's willingness to incur expenses to travel to the area, which would include items such as gasoline and other expenses associated with travel that would not normally be incurred if the area were not present.

Option demand may also be reflected in the respondent's answer. The respondent may not be a participant in recreation, but would like to see quality maintained for future generations to enjoy or maybe just the satisfaction of knowing that quality will be improved.

The following section presents the empirical results.

Empirical Results

Population characteristics of the sample

Data was collected from 294 questionnaires. Of this total, 177 interviews were completed in the inner stratum and the remaining 117 interviews were from the outer stratum. Table 1 of Appendix B lists the present address of the respondents by absolute frequency and percent of total.

It was stated in the last section that the head of the household was believed to be the best in indicating family preferences. In 58 percent of the households interviewed the respondent was the head. Also mentioned in the last chapter was the division of inner and outer stratums by sex to account for the predicted disproportionate number of females interviewed. As it turned out females were the respondent in 63 percent of the households interviewed. When survey results were extrapolated to the total population of the survey area basic raising factors or what are commonly termed "jack-up" values were determined by the Statistical Laboratory (discussed in Appendix C).

The age of the head ranged from 19 to 93 years of age. Considerably higher than the 1970 national median age of 28.1 years was this survey's median of 44.7 years (12, p. 132). Table 2 of Appendix B presents age characteristics of the population. Education of the household head is summarized in Table 3 of Appendix B. It was found that the median educational level attained about 12 years. Residency characteristics of the household head are summarized in Tables 4 and 5 of Appendix B. The range of years living at the present address was 0 to 69 years with a mean of 12 years. Higher figures were obtained for total years of residency in Iowa. The range was 0 to 93 years having a mean of 40.9 years. Residential categories that the household head has spent half or more of his life in are listed in Table 6 of the same Appendix. Occupation and present status of occupation of the household head are presented in Tables 7 and 8 of Appendix B. Occupations were classified into nine categories. Professional and craftsman categories were the two largest with 20.1 percent and 15.6 percent of the total respectively. Working household heads comprised around 73 percent. This figure was obtained by summing the status categories of working and teacher at college level. Other categories, such as student and housewife were not classified as working.

Household size varied from 1 to 9 persons. The number of members occurring most frequently was two people or around 34 percent. Mean size of family was nearly 3 members. Table 9 of Appendix B presents the absolute frequency and percent of the various household sizes.

Household income (gross) was divided into six different categories ranging from less than \$3000 per year to over \$25,000 per year. Table 10 of Appendix B summarizes household income. Mentioned in the last section was the "touchiness" of asking questions concerning income. Possibly as a result of this 17 households did not respond to the household income question. To account for this the household income of these households was approximated by interpreting other household data, such as education, occupation, address, and age of members. These adjustments are shown in separate columns in Table 10.

Distance, an important factor in determining whether or not a household will participate in a recreation area, was calculated using road distances from household location to Soper's Mill. Soper's Mill is located approximately 6 miles north of Ames. The range of distances was from a minimum of 5 miles to a maximum of 60 miles.

Household preferences for "cleaner" water Although no explanation of the present water quality conditions was given to the respondent, a very high percentage, nearly 86 percent, of the households thought they would appreciate cleaner water when participating at the green-belt facility. The results of this question are listed by number and percentage in Table 12 of Appendix B. Breakdown of those responding who would appreciate "cleaner" water by the household characteristics discussed above was originally contemplated, but by the very high percentage responding 'yes' to this question it can be concluded that "cleaner" water would be appreciated by most regardless of household characteristics.[1]

However, when the respondent was asked is the Skunk River "clean" enough for swimming and wading a much lower percentage, about 55 percent, replied 'no'. A much higher percentage of the households, 30.6, did not know whether or not the river was clean enough for swimming and wading as compared to 8.2 percent who did not know whether they would appreciate "cleaner" water while participating at the green-belt facility.

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[1]Statistical work on this question would not show anything more than what has been concluded.

Evidently, the respondents realized that swimming and wading required a better level of water quality and were not sure that the river met these standards.

Variables used in the study The variables that were used in this study are listed in Table 4.1 which is a correlation matrix of these variables. By observation of this matrix much can be learned about the relationships between the various variables. It will be referred to in the following text.

Several of the variables required some form of transformation for a more normal distribution of frequencies. The following variables; visits to green-belt facility, (1), willingness-to-spend to visit or establish green-belt, (2), additional visits to green-belt, (3), willingness-to-spend to visit or establish green-belt additionally, (4), total visits minus original visits, (5), total dollars minus original dollars, (6), years household head at present address, (18), and years household head lived in Iowa, (19), were all transformed by taking fourth root values.[1] By taking the fourth root, problems are avoided when zero values are to be transformed, i.e., the logarithm of zero is meaningless. This transformation approaches approximately the natural logarithm of the same number. In the case of the income variable, (9), the natural log of income mean was used. Square root transformations were done on members in household (12) and distance to Soper's Mill (13).

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[1]Variables (total visits)$^{\frac{1}{4}}$ - (original visits)$^{\frac{1}{4}}$ and (total dollars)$^{\frac{1}{4}}$ - (original dollars)$^{\frac{1}{4}}$ are proxies for additional visits and additional willingness-to-spend to visit or establish a green-belt facility, respectively, which refer to questions 10(c) and 10(a) concerning water quality in the green-belt facility. Numbers in parentheses are variable numbers (see correlation matrix).

TABLE 4.1. Correlation matrix for variables in study

	1	2	3	4	5	6	7	8
1. $(\text{Visits})^{\frac{1}{4}}$	1.0	.62	.39	.31	.00	.00	-.43	.17
2. $(\text{Dollars spent})^{\frac{1}{4}}$		1.00	.33	.44	-.07	.06	-.34	.09
3. $(\text{Additional visits})^{\frac{1}{4}}$			1.00	.57	.33	.71	-.34	.07
4. $(\text{Additional dollars})^{\frac{1}{4}}$				1.00	.44	.60	-.17	.05
5. $\left(\begin{matrix}\text{Total}\\ \text{visits}\end{matrix}\right)^{\frac{1}{4}} - \left(\begin{matrix}\text{original}\\ \text{visits}\end{matrix}\right)^{\frac{1}{4}}$					1.00	.54	.05	-.07
6. $\left(\begin{matrix}\text{Total}\\ \text{dollars}\end{matrix}\right)^{\frac{1}{4}} - \left(\begin{matrix}\text{Original}\\ \text{dollars}\end{matrix}\right)^{\frac{1}{4}}$						1.00	-.16	.00
7. Age of Head							1.00	-.35
8. Grade of Head								1.00
9. Natural logarithm of income mean								
10. R. lived in city of pop. greater 10,000								
11. R. lived on farm								
12. $\left(\begin{matrix}\text{Members of}\\ \text{household}\end{matrix}\right)^{\frac{1}{2}}$								
13. $\left(\begin{matrix}\text{Distance to}\\ \text{Soper's Mill}\end{matrix}\right)^{\frac{1}{2}}$								
14. Head is professional								
15. Head is craftsman								
16. Present address in Des Moines								
17. Present address on farm								
18. $\left(\begin{matrix}\text{Years at present}\\ \text{address of head}\end{matrix}\right)^{\frac{1}{4}}$								
19. $\left(\begin{matrix}\text{Years lived in}\\ \text{Iowa by head}\end{matrix}\right)^{\frac{1}{4}}$								

9	10	11	12	13	14	15	16	17	18	19
.23	-.11	-.04	.44	-.31	.11	.17	-.16	-.03	-.23	-.34
.17	-.14	.03	.07	-.26	.11	.01	-.15	-.03	-.18	-.23
.18	-.08	.04	.12	-.13	.05	.07	-.05	-.04	-.20	-.19
.16	-.08	-.01	.05	-.06	.01	.07	.01	.04	-.06	-.08
.03	.01	-.03	-.05	-.06	-.09	.13	.02	.01	-.01	.10
.13	.02	.02	.02	-.03	.00	.07	.02	-.07	-.18	-.08
-.30	.07	.09	-.38	.12	-.20	-.13	-.08	.08	.63	.65
.39	.09	-.20	.09	-.09	.60	-.12	.00	-.12	-.25	-.50
1.00	-.03	-.02	.38	-.05	.15	.16	-.07	.10	-.01	-.26
	1.00	-.56	-.04	-.20	.10	.01	.28	-.24	-.02	-.03
		1.00	-.10	-.19	-.14	-.06	-.27	.42	.10	.14
			1.00	.07	-.06	.21	-.06	.13	-.12	-.25
				1.00	-.22	.12	.47	-.03	.01	.07
					1.00	-.22	-.07	-.14	-.16	-.37
						1.00	.04	-.11	-.12	-.04
							1.00	-.29	-.06	-.01
								1.00	.17	.13
									1.00	.55
										1.00

Some variables were represented by the use of zero-one variables. Zero-one dummy variables were implemented for the following variables; respondent lived in city of population greater than 10,000, (10), respondent lived on farm, (11), household head was a professional, (14), household head was a craftsman, (15), present address in Des Moines (including Urbandale)(16), and present address on farm, (17).[1] In generating the variable, one was given to the household with the variable characteristic and zero given to all other households interviewed. For example, if the occupation of the household head was "professional" the number 1 was given to these households having a professional head and those households not having a professional head were given the number 0.

Multiple regression analysis In order to determine what variables were significant in explaining respondent's willingness-to-visit, (1), willingness-to-spend to visit or establish green-belt, (2), and the analogues of these concerning additional visits, (3), and willingness-to-spend to visit or establish a green-belt additionally, (4), when water quality improved a step-wise regression method was used.[2]. Basically the method was finding the variable that had the highest partial correlation with the dependent variable and using the F-test for significance. If significant the variable was fitted in the linear regression equation.[3]

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[1]Only professional and craftsman were represented enough in the population sample to be generated as independent variables. The other variables pertaining to rural or city residency were thought to represent the respective attitudes of those areas.

[2]See Steel and Torrie (48).

[3]Computer programming done by Iowa State University Statistical Laboratory.

Then holding the first independent variable that was found to be significant constant, other independent variables were checked for the one with the second highest partial correlation coefficient. This variable, if found significant, was also fitted in the regression equation. The procedure was repeated until all variables that were found significant using a F-level of 3.0. Several of the variables were closely related to one another and if both were found significant the latter to be fitted was discarded. For instance using the correlation matrix of Table 4.1 it can be seen that a high correlation, .65, exists between age of household head, (7), and number of years household head has lived in Iowa, (19).

Additional visits with water quality improvement

In order to make sense of the data that follows some mention is necessary of the amount of visits the interviewed stated they would pursue if a green-belt facility were established. Most of the households interviewed, 88 percent, said they would provide visits to the green-belt facility. When the survey data was extrapolated to the total population using the appropriate raising factors it was found that nearly 2,800,000 visits would be made. This figure, according to Schellenberg (42), translates to 5 or 6 visits per year for every person in the survey area or 10 times the amount of visits that could be reasonably expected to visit the green-belt facility (27). Schellenberg gives four reasons for this exaggerated figure. They are (1) undue optimism on the part of the respondents, (2) public good characteristics of the green-belt area,

(3) small sample size which limited results, and finally (4) respondent's attempt to please the interviewer.

The majority of those replying said they would provide additional days to the green-belt facility when improved water quality was present. However, the percentage of 54.3 is lower than what was registered above for visits to the green-belt facility. Table 4.2 presents number and percent of households providing additional visits per year. Nearly 4 times more respondents replied that they would not provide additional visits, 45.7 percent, compared to those that would not provide visits to the green-belt facility, 12 percent. The mean for additional visits was 7.6 with a median of 2.96 making the distribution skewed to the left. Total additional visits in the sample were calculated to be 2,132. When these survey figures were extrapolated to the total population of the study area, using the appropriate raising factors, the total visitation was slightly larger than 1,100,000. This figure was significantly smaller than the one for visits, but may be a more reasonable estimate.

Undoubtedly, the reasons given by Schellenberg can be applied in interpreting the additional visits figure. However, it should be remembered that water quality was thought of in the green-belt facility context, i.e., free-flowing stream. Water recreation activities that occur in the green-belt facility are principally not of the primary contact kind.[1] Had the respondent been directed to thinking of reservoir and lake forms of recreation, where primary contact forms are more

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[1] See Schellenberg (42) Table 7-9.

TABLE 4.2. Additional visits to Green-Belt when cleaner water is present in Skunk River (per household)

Number of Additional Visitor Days per Year	Absolute Frequency	Percent[a]	
0	128	43.5	45.7
2-3	19	6.5	6.8
4-6	27	9.2	9.6
7-8	25	8.5	9.0
9-11	20	6.8	7.1
14-15	12	4.1	4.3
16-19	20	6.8	7.1
21-22	4	1.3	1.5
26-30	13	4.5	4.6
33-34	4	1.3	1.4
42-45	3	1.0	1.1
60-68	4	1.4	1.4
76 max	1	.3	.4
- did not need to answer question	10	3.4	100.0
- no response, don't know	4	1.4	
Total	294	100.0	

Mean = 7.6
Stand. Deviation = 12.0
Median = 2.96
Total additional visits in sample = 2132

[a]Percent column on right are percentages of those who answered question 10(c).

prevalent, he may have raised his estimated number of visits. In this context the total visitation figure that was extrapolated may be a fair estimate, although one that is an "educated guess". Nonetheless, the figure does give some indication to the desirability of improved water quality. Further research is required to substantiate increased visitation when water quality is improved for different recreation areas.

Multiple regression results In attempting to identify which household characteristics were important in explaining visitation multiple linear regression equations were generated. The results of these equations are presented in Table 4.3.

Three variables were found to be significantly related to additional visitation. Visits to green belt, as expected, were highly related positively to additional visits. It would seem those visiting would naturally want to maximize their recreation experience and improved water quality would presumably increase their enjoyment. Age of the head was found to be highly related negatively, also as expected, in providing additional visits. Older people do not participate in outdoor recreation activities compared with younger groups. The last variable found positively related to additional visitation was the occupation of the household head as a craftsman, although at a lower level of significance. Due to the low coefficient of determination, R^2, these equations are not good predictors. That is, there is a lot of variation not explained by these regression equations. This might mean that the variables might not have the right values or coefficients. However, the significant variables do give some indication of the additional visitation by those subgroups that they represent.

TABLE 4.3. Results of multiple regression on visitation and additional visitation

Dependent Variable	R^2	Constant	Independent Variable: $\left(\text{Visits to Green-belt}\right)^{\frac{1}{4}}$ (1)	Age of Head (7)	$\left(\text{Members of household}\right)^{\frac{1}{2}}$ (12)	$\left(\text{Distance to Soper's Mill}\right)^{\frac{1}{2}}$ (13)	Head is Craftsman (14)
$(\text{Visits to Green-belt})^{\frac{1}{4}}$	.376	2.055		-0.011 (.002)***	0.588 (.097)***	-0.159 (.027)***	0.232 (.114)*
$\left(\text{Additional visits to Greenbelt}\right)^{\frac{1}{4}}$	.115	1.834		-0.018 (.003)***			
$\left(\text{Total Visits}\right)^{\frac{1}{4}} - \left(\text{Original visits}\right)^{\frac{1}{4}}$	.018	.166					0.141 (.068)*
$\left(\text{Additional visits to Green-belt}\right)^{\frac{1}{4}}$	.150	.194	0.468 (.072)***				

R^2 = coefficient of correlation
Number in brackets = standard error
Number above standard error = slope coefficient

*** = level of significance of .005.
** = level of significance of .05.
* = level of significance of .1 .

Additional willingness-to-spend for cleaner water in green-belt facility

Again a summary of this study's analogues on the Schellenberg study is required to communicate properly the monetary figures obtained for an improvement on water quality. The mean of those willing-to-spend to visit or establish a green-belt facility was about 25.5 dollars and a median response of nearly 10.0 dollars. When the appropriate raising factors were used to extrapolate survey data to the total population of the survey area the amount obtained was 4,042,000. This figure can be interpreted to be the maximum value of monetary benefits derived from the green-belt facility. Schellenberg states the same previous reasons for possible overstatement of this benefits figure. However, he argues that this figure may be a fairly true approximation. He states:

> ...respondents were asked to state the most money they would spend. It is not necessary that they do spend what they say, since if the facility is made available, those who stated large amounts may never be required to actually spend the amount stated. Unfortunately, there appears to be no way that the 4 million dollars of benefits can be tested as being an accurate estimate of total benefits unless the green-belt system is actually built and, after subtracting transportation costs and related variable visit expenses, the remainder is collected by a discriminating monopolist (42, p. 191).

Monetary benefits from an improvement in waters used for recreation purposes can be estimated by finding the total additional willingness-to-spend from the households interviewed. Again the data showed lower measures of location, i.e., mean and median. The mean was about $8.90 and median 0.0 dollars. This median of 0.0 dollars means that half or more of the respondents said that they would not contribute additional dollars for cleaner water in the green-belt facility. Although, the majority were not willing-to-spend additional dollars several indicated they would spend as much as 100 dollars per year for cleaner water in the Skunk River. Table 4.4 summarizes the results of the additional dollars households were willing-to-spend to visit or establish improved water quality on the green-belt area. However, a fairly sizable amount of about 1,470,000 dollars was obtained when the data was extrapolated to the population of the survey area. By taking the total additional visitation and the total additional dollars a mean dollars per visit of 1.37 was calculated.

The 1.5 million dollars of benefits can be interpreted by some using the reasons given in the preceding explanation. However, this researcher felt that this figure is a good approximation of the benefits stemming from an improvement of water quality in the green-belt facility. If other recreation areas, where primary contact recreation prevails, were to be the subject of similar questions the total benefits figure may be higher. Again this is only an "educated guess" and further research is necessary to substantiate such a statement.

Multiple regression results Four variables were found to be significantly related to additional willingness-to-spend for an improvement in water quality in the green-belt facility. It seemed logical that additional visits to the green-belt would be highly related positively. Also expected to be directly related was the natural logarithm of the income mean. However, it was significant at a lower level in both equations that it occurred. Both age of household head and years household head has resided at present address were found to be negatively related. Mentioned before was the high correlation between these two variables. Distance was found to be highly related negatively to

TABLE 4.4. Additional willingness-to-pay with cleaner water in Skunk River

Dollars per year	Absolute Frequency	Percent[a]	
0	154	52.4	57.9
1-3	9	3.0	3.4
4-6	28	9.6	10.5
8-12	24	8.1	9.0
14-17	5	1.7	1.9
20	5	1.7	1.9
25	19	6.5	1.1
30	2	.7	.8
40	3	1.0	1.1
50	10	3.4	3.8
66	1	.3	.4
75	1	.3	.4
100	5	1.7	1.9
- did not need to answer question	10	3.4	100.0
- no response, don't know	18	6.1	
Total	294	100.0	

Total additional willingness to pay in sample = 2361
Mean = \$8.88
Stand. Deviation = 18.3
Median = 0

[a]Percent column on right are percentages of those who answered question 10(d).

willingness-to-spend to visit or establish a green-belt, i.e., dollars spent. Referring to Table 4.1, the correlation is seen to be quite high, .44, between dollars spent and additional dollars spent. It can be inferred that distance is also a factor relating to willingness-to-spend to visit or establish better water quality in the green-belt facility.

The coefficient of determinations, R^2, of additional dollars spent were low except for one equation which had an R^2 value of .325. The results of this equation appears on the bottom row of Table 4.5. In this equation the variable additional visits to the green-belt facility was used as an independent variable.

Perspective of results

Economists have long been troubled by measurement problems when attempting to arrive at empirical estimates of some of the external diseconomies from natural resource deteriorating activities. Though if society is to allocate resources efficiently it is important that it has some idea of the costs of achieving abatement of the deteriorating activities and the benefits coming from the improvement. Recreation as mentioned in Chapter II is a beneficial use of water, but other uses often limit the water resources recreation potential. This assumes that one of the social costs of deteriorated water quality is that of recreational development and use foregone.

From the results of this study it appears that water quality is a definite factor influencing outdoor recreation demand. Although the range of recreation was limited to free-flowing stream recreation in the reservoir alternative, the green-belt facility, sizable figures were

TABLE 4.5. Results of multiple regression on willingness and additional willingness-to-spend

Dependent Variable	R^2	Constant	Independent Variable[a]: $(\text{Visits to Green-belt})^{1/4}$ (1)	Additional visits to Green-belt (3)	Age of Head (7)	Nat'l log of Income mean (9)	$(\text{Distance to Soper's Mill})^{1/4}$ (13)	$(\text{Years Head at address})^{1/4}$ (18)
$(\text{Willingness-to-spend to visit or establish green-belt})^{1/4}$	.165	3.284			-0.019 (.004)***		-0.158 (.042)***	
$(\text{Willingness-to-spend to visit or establish green-belt additionally})^{1/4}$	.044	-0.366			-0.008 (.004)**	0.173 (.094)*		
$(\text{total dollars})^{1/4} - (\text{original dollars})^{1/4}$	.047	-0.138				0.048 (.022)*		-0.070 (.026)**
$(\text{Willingness-to-spend to visit or establish green-belt})^{1/4}$	.383	0.120	0.852 (.069)***					
$(\text{Willingness-to-spend to visit or establish green-belt additionally})^{1/4}$	.325	0.229		0.616 (.057)***				

R^2 = coefficient of determination; number in brackets = standard error; number above standard error = slope coefficient.

[a]*** = level of significance of .005; ** = level of significance of .05; * = level of significance of .1 .

obtained for both total additional visits and total additional willingness-to-spend when water quality improved. The total monetary amount of additional willingness-to-spend can be taken as the benefits coming from cleaner water in the green-belt facility.

Water quality improvement was thought of in the green-belt facility context. As mentioned before in this chapter the public may have felt that water quality improvement would be more desirable in recreation areas where primary contact forms of recreation occur. By improvement of water qualities in recreation areas, recreational benefits would be maximized. Maximization of recreation benefits however, does not necessarily mean that regional income will be increased. True is the fact that with increased recreation participation expenditure of funds by recreationists would also increase. Some of these funds are spent in the locality, thus enhancing regional income. If water quality is left in its less than desirable state people can find substitute recreation areas with improved water quality present there which involves additional costs of travel. Also they may spend their funds for different forms of recreation in the area. In both cases there is a welfare loss to the recreationist in that he is forced to go to second choices. Further research is necessary to determine the effects of improved recreation resource qualities and the benefits stemming from the improvement in the context of a region. This could be accomplished by using a regional model. Recently, a regional model has been developed by Abu Kishk (1) for the Skunk River basin, which does not include the outdoor recreation. By using 37.5 mg/l of suspended sediment for primary recreation and taking data from Abu Kishk's model a cost figure can be arrived at for the region. This cost figure would represent additional costs to the agricultural sector in the form of reduced incomes. If improved water quality and the attendant increase in recreation demand have significant effects in increasing the demand in other sectors of the regional economy these monetary benefits can be added to the additional recreational benefits of this study and a total benefits figure obtained. Then a comparison of the costs and benefits figures could be done.

CHAPTER V. SUMMARY AND CONCLUSIONS

Development of the model and its application to the study area have been presented in this study. The empirical results from the survey were also discussed. This chapter summarizes and evaluates the entire report with respect to its objectives, accomplishments, and limitations. Recommendations for further research, the last objective of this study, are included here.

Summary

Outdoor recreation is an important use of this country's natural resources. The quality of these resources used for outdoor recreation purposes can affect the recreational participant's satisfaction by making his experience either more or less enjoyable. Although problems exist with quantitative measurement of natural resource quality, an attempt at such a measurement was made in this study by determining the change in outdoor recreation demand with an improvement in natural resource quality. To accomplish this a public survey was developed to obtain directly from the public their preferences for quality of water resources. An idea of the benefits stemming from improved water quality were found from the public's change in visitation to the Skunk River study area and their willingness-to-pay for the improved water quality. Each of this study's objectives, as presented in the first chapter, are now summarized.

Accomplishment of study objectives

The first objective of this study was to identify the quality characteristics of natural resources used for outdoor recreation and to review the methods for estimating demands for outdoor recreation. Recreational resource quality was defined as a demand-oriented concept. This was understood to mean that the properties of a recreational resource influence the kind of recreation activity. Quality levels vary from one area to another, and hence, the kind of recreation found there also may vary. For the purpose of this study water resource quality was used since so many recreational activities are associated with water resources. Water resource recreation was considered to have two types of uses in terms of water quality. They were given as primary contact and secondary contact forms of recreation, i.e., swimming and fishing, respectively.

A variety of agents were identified in affecting the quality of water resources. Of these, soil sediment and associated materials from the agricultural sector were indicated to be one of the principle substances affecting the water quality of streams and lakes in Iowa. Suspended soil sediment was shown to have the characteristic of forming a colloidal suspension which can transport other potentially harmful materials. Any material that enters a water resource was considered potentially harmful if it was of sufficient concentration.

In the second chapter recreational resource quality was analyzed through a three-dimensional framework consisting of: (1) the physical dimension, (2) the economic dimension, and (3) the structural or institutional dimension. It was shown that rather than being independent of one another, the three dimensions are interrelated. In order to effectively preserve the quality of recreational resources those in charge of management should possess knowledge of what the prevailing physical conditions are and what is physically possible, what is economically feasible, and institutionally permissible.

The discussion of the economic dimension in Chapter II revealed that the price system did not allocate natural resources to meet recreational resource quality requirements. Allocation of natural resources to outdoor recreation and the attendant qualities desired for outdoor recreational activities were characterized by external effects that create market failure conditions. The three types of externalities; (1) ownership, (2) technical, and (3) public good, are all present with respect to outdoor recreation. These externalities were examined by citing the example of a river with deteriorating water quality due to suspended sediment.

Due to these external effects, especially public good characteristics, of recreational resource allocation and its associated qualities, intervention by the "visible hand" of government was seen to be warranted. In addition, public provision of recreational resources seems reasonable because of the extremely large scale often necessary for development with the possible initial absence of demand to support such a large investment, i.e., large reservoir project. Another reason given was the uncertainty of future demands for outdoor recreation which makes private investment unattractive. If quality of a recreational area presents health hazards, public investment benefits society as a whole by eliminating potential epidemics.

Institutions in our society are responsible for most of the social choices made. It was shown that there are many facets to recreational resource quality problems. Therefore, if efficient allocation of natural resources and the preservation of their characteristic qualities is to be made, many disciplines are necessarily involved. Problem solving in this manner was described as the multidisciplinary approach.

Various methods for estimating outdoor recreational benefits exist in the literature and were reviewed in Chapter III. None of these are completely satisfactory in measuring recreational resource benefits. Important to these methods is the recreational experience or user satisfaction that the recreational participant receives while pursuing recreation. Most of these participants prefer a certain resource quality. If the recreational resource is of an inferior quality level, the user satisfaction of the person participating in a recreational activity will decline.

The concept of recreational resource quality, however, is not evident in many of the cited demand prediction models. Clawson mentions the quality of the recreational site as a factor in the participant's recreational experience, but fails to incorporate resource quality in his adaptation of the Hotelling travel-cost method. Among the modifications that have been made by various researchers to the basic travel-cost method of determining recreational resource benefits, three variables seem to incorporate the concept of recreational resource quality. These were identified as: (1) the recreational resource quality variable (E), (2) the alternative recreation activities variable (Vi), reflecting the tastes of the recreational participant, and (3) the intensity of preference variable (T) that a recreational participant has over a base recreational area.

Two benefits unlikely to be measured by all of the prediction methods discussed in Chapter III, were the two closely related demands of opportunity effect and option demand. Both of these demands seldom become effective demands, and as a result are not likely to be measured. It was shown that recreational resource quality might lead to these demands becoming effective demands. In the case of the opportunity effect, improvement of a recreational area may make a person's recreational experience more enjoyable, whereas before the improvement the person did not enjoy the recreation offered at that site. Option demand was shown to reflect some people's desire to preserve a certain quality of a recreational resource even though they may never become active participants at that area.

The second objective was to develop a model to appraise peoples preferences for the quality of water-oriented recreational resources. It was assumed in this study that knowledgeable recreation participants preferred better quality over lesser quality in their recreation experience, and therefore, maximized their utility. Undesirable recreational resource quality levels indicate a social cost registered in terms of recreation foregone.

In order to aid in the measurement of increased benefits, resulting from an improvement in a water recreational resource, some sort of monetary measure was helpful. The interview technique was thought best in finding out the public's willingness-to-pay for improved recreation opportunities. A questionnaire was developed that attempted to evaluate the public's willingness-to-visit a free-flowing stream in the proposed green-belt recreation facility along the Skunk River after an improvement in water quality had been made, and also determine the public's willingness-to-pay for such an improvement in water quality.

The third objective was accomplished by utilizing the questionnaire that had been developed. Data was collected from 294 personal interviews in about a 60 mile radius from the center of the proposed green-belt recreation facility. A discussion of the survey design and presentation of the empirical results from which inferences on the public's preferences for recreational resource quality were drawn was the content of Chapter IV. A brief summary on the important findings now follows.

Nearly all, 86 percent, of the respondents interviewed thought that they would appreciate "cleaner" water when participating at the proposed green-belt facility. However, when the respondent was asked whether or not the Skunk River was "clean" enough for swimming and wading the percentage that replied 'no' slipped to 55 percent, with a high percentage unsure of the river's fitness for body contact.

When the respondents were asked how many additional days they would spend in the proposed green-belt facility after water quality improvement had taken place, a figure of 2,132 total additional visits was obtained. When this was extrapolated to the total population using the appropriate raising factors, total additional visitation was slightly larger than 1,000,000. It must be remembered that this study's questions were included in the Schellenberg (42) questionnaire. Respondents were almost in a "conditioned" state of thinking of water recreation in the context of a free-flowing stream, i.e., non-contact forms of water recreation. The total visits to the green-belt facility, measured by Schellenberg, was felt to be a gross overestimate of actual visitation. However, though the figure of additional visitation to the green-belt facility may also be an overestimate, it might be somewhat closer to actual visitation with improved water quality. The reason given in Chapter IV was that had the respondent thought of primary recreation, direct water contact forms of recreation at other areas such as lakes and reservoirs, the response given might have been fairly accurate.

Regression analysis was used to obtain household characteristics that were important in explaining additional visitation by the respondents. Three variables were identified as being significantly related. Visits to the green-belt, as expected, was positively related as was the household head's occupation of craftsman. Age of the household head was found to be negatively related, which seemed logical. These are summarized in Table 4.3.

Willingness-to-spend for improved water quality was the next category investigated. Respondents were asked to state the additional dollars they would spend for improved water quality in the green-belt facility, i.e., additional willingness-to-spend. Monetary benefits from an improvement in water quality was obtained by finding the total willingness-to-spend by the interviewed households. Although the majority of the households were not willing-to-spend additional dollars, a fairly substantial figure, 1,470,000 dollars, was still calculated when the data was extrapolated to the entire population of the survey area. This figure was thought to be reliable, although it might be questioned that some households would be willing to spend 100 dollars a year for improved water quality.

Regression analysis was again employed. Four variables were found to be significantly related to additional willingness-to-spend for water quality improvement in the green-belt facility. As expected, additional visits to the green-belt facility was highly related positively. The natural logarithm of the income mean was also found to be positively related. Distance, along with age of household head and years household head had resided at present address were described as being negatively related to additional willingness-to-spend for improvement of water quality in the green-belt facility. The results of the multiple regression equations appear in Table 4.5.

The last objective of this study was to suggest additional research needed to understand the quantity and quality components of recreational resources. These research needs are the result of limitations from this study.

Limitations of the Study

This study attempted to relate the physical qualities of water oriented recreation, as exemplified by the free flowing stream in the green-belt facility, to the preferences of the public. However, limitations were present in attempting to identify and measure the public's preferences. The major limitations are listed below.

1. Only water recreation activities associated with the free-flowing stream of the proposed green-belt facility along the Skunk River were actually considered in the survey questionnaire. Other recreational areas offering other forms of recreation might indicate different public preferences for recreational resource quality.
2. No explanation of the present water quality conditions was given on the survey questionnaire. The way the questionnaire was worded could have encouraged the respondent to desire improved quality. Some degree of bias was introduced.
3. Estimates of additional visitation and additional dollars might have been closer to the actual had a larger sample size been implemented.
4. Only persons 18 years or older were interviewed resulting in the possibility that the opinions of children, usually recreational participants, were not measured.
5. The respondent was told that improved recreational water quality was possible even though it may not have been economically possible or institutionally permissible.

Conclusions

The principle problem that this study was directed at was to illustrate how natural resource quality affects demand for outdoor recreation. This problem was analyzed in the region of the proposed Ames Reservoir in Central Iowa.

Empirical measurement of external diseconomies stemming from natural resource deteriorating activities was difficult. This study took the affirmative answer that some measure was possible to obtain and which could be used to show the benefits coming from curtailing the resource degrading activities, i.e., water quality improvement. The benefits could be compared to the costs of improving the quality to determine the economic appropriateness to such an endeavor. Hence, the economic trade-offs between recreational resource quality and natural resource development.

It can be concluded that water quality is a definite factor influencing outdoor recreation demand. By the improvement of natural resources used for outdoor recreation the benefits from outdoor recreation would be maximized. This does not, however, mean that regional income in the area of the improved recreation would be increased. As pointed out in the text, if inferior recreation resources exist, the recreation participant is forced to go to second choices and in so doing a welfare loss is registered.

Institutions should realize that quality has values other than the going market price. Quality has intangible values and attempts should be made for its preservation. If quality deteriorating activities are present, they should not be permitted to reach a stage of resource irreversibility. And finally, the participating public should be involved in recreational resource development.

Additional Research Suggestions

From this study's findings further research can be initiated. The following gives several ideas:

1. The public's preferences for recreation resource qualities of other recreation areas needs to be determined.
2. Natural resource, specifically recreational resources, could be ranked or classified as to their quality levels, i.e., an inventory.
3. Study is needed to see that quality is incorporated into developmental projects where recreation is concerned.
4. If further surveys are undertaken similar to the one used in this study, methods should be developed to eliminate bias.
5. A study is needed to determine the effects that an improvement in recreational resource quality would have in the context of a region. This would incorporate the use of a regional model.
6. Research would be helpful to determine the redistribution of income that would accompany improvement of recreation resource quality.

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APPENDIX A: THE SURVEY QUESTIONNAIRE

No. __________

Form III
May, 1973

Central Iowa Environmental Study

Economics Department
and
Statistical Laboratory
Iowa State University

Head of household ______________ Interviewer ______________________

Address ______________________ Seg. No. ______ Household No. _______

Town ______________________ Date Time

Telephone No. _____ (Area) ___________ 1st call ____________ ____________

Name of respondent _____________ 2nd call ____________ ____________

Starting time _________________ 3rd call ____________ ____________

Hello. I am ____________ (your name) representing Iowa State University at Ames. You may know that the Army Corps of Engineers is considering building a reservoir on the Skunk River. The University is interviewing persons who live in central Iowa in order to make estimates of the kinds of values that people place upon natural resources that would be flooded by construction of the proposed Ames Reservoir. The study will make possible a better comparison of all the money and non-money benefits and costs of the proposed lake. The information is important in the planning of such facilities as parks and recreational areas.

First, could we have the name of the head of the household, and spouse, if any.

SECTION I

[INTERVIEWER: Copy the name of the head of the household and spouse, if any, listed on the screening sheet.]

Are there any other members living in this household? ____ Yes ____ No

If YES, what are their names, starting with the oldest? (Complete Cols. a through g for ALL members of the household.)

(a) How is ______________ related to the head of the household?

(b) Male or female:

(c) How old was (he) (she) on (his)(her) last birthday?

(d) How many years of schooling has (he)(she) completed?

(e) How many years has ___________ lived at this address?

(f) How many years has ___________ been a resident of Iowa?

[For members 18 and over:]

(g) What is __________'s occupation - what kind of work does (he) (she) do?

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Name	Rel. to head	Sex	Age	Grade comp.	Years lived here	Years Iowa resident	*Occupation
1.	Head						
2.							
3.							
4.							
5.							
6.							

* If retired, please note previous occupation

SECTION IV

9. Suppose that about 1/2 of the forested land and virgin areas between Ames and Story City were purchased by the public and developed into a "green-belt" area. For our purposes, we will say that a "green-belt" area is a recreation and preservation area with a natural stream as the center of attraction, in which facilities have been provided such as trails, picnic sites, camping areas and parking.

(a) Look at this (BUFF) card and tell me about how many days a year you think you and other members of your family would visit such a site. Would you say:

Days per year		Family member number(s)
1 - 2	seldom	
3 - 5	a few times	
6 - 10	several	
11 - 15	frequently	
16+	great deal	
0	none	

[INT: If every family member responds "none", ask (b) and then skip to (d)]

(b) Why do you think this household would not visit the area?

_____ too far
_____ prefer a lake
_____ not enough time
_____ very little participation in outdoor recreation
_____ other (explain) ______________________________

(c) In what recreational activities would you or members of your family probably participate in at such an area? (Read each and check one or more)

Yes	No	
_____	_____	picnicking
_____	_____	driving for pleasure
_____	_____	fishing
_____	_____	hiking
_____	_____	biking
_____	_____	observing wildlife
_____	_____	camping
_____	_____	canoeing
_____	_____	mushroom hunting
_____	_____	sledding
_____	_____	ice skating
_____	_____	skiing (snow)
_____	_____	other (specify) ____________________

(d) Even though this "green-belt" area might receive state or federal aid, it may be necessary to provide additional financial support. What is the most money, if any, that you and your family would be willing to spend per year to visit the area or to aid in its establishment?

$__________per year

[If zero dollars] Why do you feel this way?
[INT: Do not read]

_____ cannot afford it
_____ other recreation areas are available
_____ this area is not worth spending money on
_____ should not have to pay to visit outdoor recreation areas
_____ other (specify) ______________________________________

10. (a) Do you think you would appreciate cleaner water in the river while participating in outdoor recreation at the area?

_____ Yes

_____ No

_____ (Don't know)

(b) Do you think the river water at present is clean enough to swim or wade in during most of the summer recreational season?

_____ Yes

_____ No

_____ (Don't know) [INTERVIEWER: If (a) = No and (b) = Yes, Skip to Q. 11]

(c) Suppose that it were possible to improve the quality of the water in the Skunk River to make it cleaner and less "murky". Fishing would be improved. If the water were cleaner in this "green-belt" area, do you think you or other members of your family might visit the area more often?

_____ Yes ⟶ About how many more days per year do you think each member of your family would visit the area?

_____ No

Additional days per year	Family member number(s)
1 or 2	
3 or 4	
5 or 6	
7 to 10	
10 +	
None	

(d) Now suppose that there could be cleaner water in this "greenbelt" area. State or federal aid might be available, but it may still be necessary for the public to provide additional financial support. Would you and your family be willing to spend any additional money per year to visit this area or to aid in its establishment if the water were cleaner?

_____ Yes ⟶ How much more would you be willing to spend per year? $____________ per year

_____ No

11. This card (hand R the GREEN card) has a wide range of income categories. Would you please tell me which letter best represents the total income of the members of this family for the year 1972. Please include all the income of every member including wages, interest, dividends, public assistance, unemployment compensation, net income from business, etc., <u>before</u> taxes.

_______ Under $3,000
_______ $3,000 to $5,999
_______ $6,000 to $9,999
_______ $10,000 to $14,999
_______ $15,000 to $24,999
_______ $25,000 and over

12. Now, considering all the things we have talked about, such as the loss of natural resources, the possibility of improved recreational facilities, the possibility of cleaner water, and so on, would you look at this (ORANGE) card and tell me which of these four choices you prefer first, second and third.

_______ 1. The green-belt area (which preserves the stream and natural surroundings)

_______ 2. The 1,400 acre recreation lake

_______ 3. The multi-purpose project (the larger project proposed by the Army Corps of Engineers)

_______ 4. Leave the area in its present state of private control.

13. Have you (the respondent) spent one-half or more of your life in any of the following categories:

_______ Farm(s)

_______ Rural nonfarm

_______ City (cities) under 10,000

_______ City (cities) over 10,000

_______ None of the above

We want to thank you so much for your cooperation and interest in this project.

__________ending time

APPENDIX B: HOUSEHOLD CHARACTERISTICS OF SURVEY'S SAMPLE POPULATION

TABLE B.1. Present address of respondents

Locality	Absolute frequency	Percent of total
Ames	47	16.0
Boone	27	9.2
Nevada	12	4.1
Madrid, Story City	7	2.4
Cambridge, Ellsworth, Roland	23	7.8
Inner Rural	30	10.2
Des Moines	70	23.8
Urbandale	13	4.4
Marshalltown, Fort Dodge	28	9.5
Webster City, Clive, Ankeny	6	2.0
Ackley, Adel, Pleasant Hill	5	1.7
Granger, Kellogg, Whitten	7	2.4
Outer Rural	19	6.5
Total	294	100.0

TABLE B.2. Age of head

Age category in years	Absolute frequency	Percent of total
19-24	30	10.2
25-30	41	13.9
31-40	59	20.1
41-50	45	15.3
51-65	59	20.1
66-80	46	15.6
81-93 (maximum)	14	4.8
Total	294	100.0

Mean = 47.2
Standard Deviation = 18.7
Median = 44.7

TABLE B.3. Education of head

Years of schooling	Absolute frequency	Percent of total
3-5	2	.7
7-8	44	14.9
9-11	45	15.4
12	103	35.0
13-16	61	20.7
17-18	20	6.8
19-22 (maximum)	19	6.5
Total	294	100.0

Mean = 12.5
Standard deviation = 3.41
Median = 12.04

TABLE B.4. Years head has lived at present address

Number of years	Absolute frequency	Percent of total
0-2	91	31.0
3-5	46	15.6
6-10	48	16.3
11-20	46	15.6
21-30	32	10.9
31-40	18	6.1
41-69	13	4.4
Total	294	100.0

Mean = 12.03
Standard deviation = 13.97
Median = 6.27

TABLE B.5. Years head has been a resident of Iowa

Number of years	Absolute frequency	Percent of total
0-2	16	5.4
3-5	5	1.7
6-10	10	3.4
11-20	17	5.8
21-30	59	20.1
31-40	47	16.0
41-60	79	26.9
61-80	52	17.6
81-93 (maximum)	9	3.1
Total	294	100.0

Mean = 40.91   Standard deviation = 22.09   Median = 39.25

TABLE B.6. Residential category in which respondent has spent half or more of life

Residential category	Absolute frequency	Percent of total
Farm	81	27.6
Rural non-farm	18	6.1
City (greater than 10,000)	52	17.7
City (less than 10,000)	133	45.2
None of the above	10	3.4
Total	294	100.0

TABLE B.7. Occupation of head

Nature of occupation	Absolute frequency	Percent of total
Professional (includes students)	59	20.1
Farmer, farm manager	33	11.2
Manager, official, proprietor	34	11.6
Clerical	26	8.8
Sales	17	5.8
Craftsman	46	15.6
Operative	28	9.5
Service worker (inc. housewife)	33	11.2
Laborer (inc. farm laborer)	14	4.8
No response	4	1.4
Total	294	100.0

TABLE B.8. Present status of occupation

Present status	Absolute frequency	Percent of total
Working	208	70.7
Unemployed	1	.3
Retired	48	16.3
Housewife	15	5.1
Student	13	4.4
Teacher at college level	7	2.4
Disabled	2	.7
Total	294	100.0

TABLE B.9. Number of members in household[a]

Number of members	Absolute frequency	Percent of total
1	51	17.3
2	99	33.7
3	43	14.6
4	45	15.3
5	28	9.5
6	17	5.8
7	10	3.4
9	1	.3
Total	294	100.0

Mean = 2.99

[a]Not listed on this table are the members under 18 years of age. 43.3 percent of the interviewed households had members younger than 18 years.

TABLE B.10. Household income

		Absolute frequency		Percent of total	
Household income (dollars per year)	Class mean (Assumed)	Original data	Adjusted for non-response	Original data	Adjusted for non-response
less than 3000	2,000	33	34	11.2	11.6
3,000 to 5,999	4,500	43	47	14.6	16.0
6,000 to 9,999	8,000	54	61	18.4	20.7
10,000 to 14,999	12,500	79	84	26.9	28.6
15,000 to 24,999	20,000	60	60	20.4	20.4
25,000 and over	35,000	8	8	2.7	2.7
refused and no response		17	0	5.8	0.
Total		294	294	100.0	100.0

TABLE B.11. Distance to Soper's Mill

Distance in miles	Absolute frequency	Percent of total
5-6	9	3.1
8-12	86	25.8
14-18	26	8.9
20	29	9.9
25-30	6	2.1
35	37	12.6
40	65	22.1
45-50	20	6.8
60	26	8.8
Total	294	100.0

TABLE B.12. A measure of appreciation of cleaner water

	Absolute frequency	Percent of total
Household appreciating	252	85.7
Households not appreciating	18	6.1
Don't know	24	8.2
Total	294	100.0

TABLE B.13. "Clean" enough for swimming and wading

	Absolute frequency	Percent of total
No	161	54.8
Yes	43	14.8
Don't know	90	30.6
Total	294	100.0

APPENDIX C: SELECTION AND USE OF THE SAMPLE

Survey Sample[1]

Sample description

The universe for this study consisted of all households in a 9-county area of central Iowa; specifically, the counties were Boone, Dallas, Hamilton, Hardin, Jasper, Marshall, Polk, Story, and Webster.

Two geographic strata were defined - an inner stratum centered around the proposed Ames Reservoir and an outer stratum consisting of the remaining area. The inner stratum consisted of all of Story County, the southwest corner of Hardin County, southern Hamilton County and eastern Boone County. Within each stratum, six substrata were identified based on size of community according to the 1970 Census population. These were:

(1) cities 25,000 and over

(2) cities 10,000 to 24,999

(3) towns 2,500 to 9,999

(4) towns 1,000 to 2,500

(5) towns less than 1,000

(6) areas outside incorporated towns and cities.

The table which follows shows the distribution of the population in each stratum by county.

About 300 completed interviews were desired, to be divided equally between the two strata. On the basis of the 1970 Census data, a sampling rate was determined for each stratum which could be expected to yield the desired number of interviews after allowing for some non-response and

---

[1]Prepared by Harold Baker of the Iowa State University Statistical Laboratory.

changes that may have occurred since the census. These rates were 1 out of 157.3 for the inner stratum and 1 out of 875.3 for the outer stratum.

The table which follows shows for the substrata consisting of incorporated communities, the total number of communities in the universe and the number selected in the sample. When all the communities in a substratum were included in the sample, the overall stratum sampling rate was applied directly to the sampling materials for each community. Otherwise, a sample of communities was selected with probabilities proportional to size in terms of Census housing units. The sampling rate within a selected community was then determined such that the product of this rate and the probability of having selected the community was equal to the overall stratum sampling rate.

Within each sample community, area segments were selected at the appropriate rate. Various materials such as Census block statistics, city directories, and aerial photographs were used to define and delineate these area segments. In the open country, an area sampling frame specifically constructed for this type of sampling was used. Segments were delineated on county highway maps.

For households containing both a male head and his wife, it was desired that the male be interviewed in about half the cases and the female in the other half. This was accomplished by designating (in a random manner) half the segments as "male" segments, in which the male would be interviewed, and the other half as "female" segments, in which the female would be interviewed. If a household had only a head (who, in that case, could be either male or female), that person was to be interviewed regardless of the segment designation.

TABLE C.1. Distribution of universe (occupied housing units)

County	Substrata						
	Cities 25,000 and over	Cities 10,000 to 24,999	Towns 2,500 to 9,999	Towns 1,000 to 2,499	Towns less than 1,000	Remainder	Total
Inner Stratum							
Boone		4,386		793	52	1,230	6,461
Hamilton				406	654	948	2,008
Hardin					544	572	1,116
Story	10,716		1,703	1,126	2,074	2,643	18,262
Total	10,716	4,386	1,703	2,325	3,324	5,393	27,847
Outer Stratum							
Boone				633	286	1,259	2,178
Dallas			2,479	2,040	1,410	2,674	8,603
Hamilton			2,922		332	908	4,162
Hardin			3,218	690	883	1,572	6,363
Jasper		5,401		1,729	1,105	3,374	11,609
Marshall	8,765			439	1,273	2,809	13,286
Polk	68,506	8,901	6,248	810	1,014	7,980	93,459
Webster	10,112			425	1,514	3,220	15,271
Total	87,383	14,302	14,867	6,766	7,817	23,796	154,931

TABLE C.2. Number of communities in universe and sample

County	Cities 25,000 and over		Cities 10,000 to 24,999		Towns 2,500 to 9,999		Towns 1,000 to 2,499		Towns less than 1,000	
	Universe	Sample	Universe	Sample	Universe	Sample	Universe	Sample	Universe	Sample
Inner Stratum										
Boone	-	-	1	1	-	-	1	1	1	-
Hamilton	-	-	-	-	-	-	1	-	4	1
Hardin	-	-	-	-	-	-	-	-	2	-
Story	1	1	-	-	1	1	2	1	10	2
Total	1	1	1	1	1	1	4	2	17	3
Outer Stratum										
Boone	-	-	-	-	-	-	1	-	5	-
Dallas	-	-	-	-	1	-	4	1	9	1
Hamilton	-	-	-	-	1	1	-	-	3	-
Hardin	-	-	-	-	2	-	1	1	7	1
Jasper	-	-	1	-	-	-	3	-	8	1
Marshall	1	1	-	-	-	-	1	-	10	-
Polk	1	1	2	1	4	2	2	1	7	-
Webster	1	1	-	-	-	-	1	-	11	-
Total	3	3	3	1	8	3	13	3	60	3

Results

Altogether, 179 occupied households were identified in the sample in the inner stratum; 146 interviews were completed for a response rate of 81.6 percent. In the outer stratum, 189 occupied households were identified from which 148 interviews were completed for a response rate of 78.3 percent.

Estimation

For purposes of estimating totals, means, and proportions, the basic raising factor (the reciprocal of the sampling fraction) was adjusted to compensate for non-response. Since the response rate differed for males and females separate adjustments were made for each sex. The adjusted raising factors were:

Inner stratum, male	211.7
Inner stratum, female	169.4
Outer stratum, male	1069.8
Outer stratum, female	968.4

Let

y_{ijk} = value of a characteristic, y, for the k^{th} person, j^{th} sex, in the i^{th} stratum

w_{ij} = raising factor for j^{th} sex in i^{th} stratum

$i = 1, 2$

$j = 1, 2$

$k = 1, 2, \ldots, n_{ij}$.

Then, to estimate a population total for the i^{th} stratum

$$\hat{Y}_i = \sum_{j=1}^{2} w_{ij} \sum_{k=1}^{n_{ij}} y_{ijk} .$$

A population mean can be estimated by

$$\hat{\bar{Y}}_i = \sum_{j=1}^{2} w_{ij} \sum_{k=1}^{n_{ij}} y_{ijk} \Big/ \sum_{j=1}^{2} n_{ij} w_{ij} .$$

If overall totals and means are desired for the combined strata, these can be obtained by

$$\hat{Y} = \sum_{i=1}^{2} \sum_{j=1}^{2} w_{ij} \sum_{k=1}^{n_{ij}} y_{ijk}$$

and

$$\hat{\bar{Y}} = \sum_{i=1}^{2} \sum_{j=1}^{2} w_{ij} \sum_{k=1}^{n_{ij}} y_{ijk} \Big/ \sum_{i=1}^{2} \sum_{j=1}^{2} n_{ij} w_{ij} .$$

These estimating procedures assume that those who were selected in the sample but were not interviewed did not differ as a group from those who were interviewed.