RECREATIONAL FACILITY PROVISION EFFECTS ON THE ESTIMATION OF DERIVED DEMANDS FOR BOATING

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Agricultural Economics

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November, 1975

Blacksburg, Virginia

ACKNOWLEDGMENTS

The author wishes to express her appreciation to the many persons without whose support this study could not be made.

Appreciation is expressed to the members of my graduate committee for their time, patience and constructive criticisms made throughout the study period. Committee members were: Dr. Sandra S. Batie, Major Professor and Assistant Professor of Agricultural Economics; Dr. Robert B. Jensen, Assistant Professor of Agricultural Economics; and Dr. Leonard A. Shabman, Assistant Professor of Agricultural Economics.

Special appreciation is expressed to my fiancee, Brent, and my parents, Cdr. (Ret.) and Mrs. Robert F. Hogue for their encouragement and support throughout the study period.

Special gratitude is expressed to Dr. Burl Long, Associate Professor of Agricultural Economics, and Charlie Gordon, former graduate student, for their friendship and support throughout my entire graduate study.

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CHAPTER I

THEORETICAL CONSIDERATIONS FOR DEMAND ESTIMATES OF RECREATIONAL BOATING

A better knowledge and understanding of the economics of outdoor recreation has been the concern of many over the past decades. Increased focus on all areas of outdoor recreation is the result of rapidly increasing participation in outdoor recreational activities. For example, by 1980, annual visitations to national forests are predicted to be double the present level. (Gilmour, 1973) Among the factors influencing this trend are population growth, greater mobility as a result of improved transportation facilities, higher per capita real incomes, and more leisure time.

This rapidly growing demand for participation in outdoor recreation increases the value of the natural resources that can be used to provide it. Moreover, increasing competition between alternative uses of scarce natural resources (e.g., land, water) make continuing adjustments in resource allocation necessary. The nation is, therefore, faced with the problem of choosing between alternative uses of resources to obtain desired results. (Knetsch, 1963) For example, water resources can be used for (solely or in a combination of) such purposes as flood control, hydroelectric power, navigation, irrigation, water supply (including industrial water supply), fish and wildlife

preservation, and recreation. Policy makers need information to facilitate resolutions of conflicting possible uses.

Only recently has outdoor recreation become a serious topic for consideration in the public policy decision making process. It was in 1962 that Congress approved Senate Document 97. This document, among other things, gave outdoor recreation full recognition and consideration as a primary purpose in water resource development project formulation and evaluation. It also implied that recreation could be evaluated in the same manner as other competing uses for natural resources. (Knetsch, 1964) There is, however, a lack of agreement on the methods used and the interpretations of these evaluations. Hence, there exists a need for more meaningful demand and value estimates for outdoor recreation. Improved demand information and its use in the evaluation of the economic benefits and costs of outdoor recreation opportunities can better serve as a basis for determining the quantities, kinds and locations of recreation resources desired. Additional information can also aid in the timing of acquisition and development of the resources. With the increasing knowledge of the demand for specific outdoor recreational activities, scarce resources can be efficiently allocated by the public planning and budgetary allocation processes. (Kalter and Gosse, 1969; Kalter, 1971)

Recreation has also become and will continue to be an increasingly important element in regional economic development. Regional impacts of proposed recreation investments could represent increases in regional incomes and/or improved income distribution within the region itself, improved geographical distribution of economic activi-

ty, and an enhancement of the regional economic base. In order for various levels of government to obtain maximum advantage of the recreation component in an area's economic growth plan, increased information on recreational demand, it's sources, and the spending characteristics associated with it is necessary. (Kalter, 1971)

Finally, recreation as a consumer good requires factors of production. A "derived" demand for certain human, natural and capital resources is created from the demand for outdoor recreation. These resources, for example, could provide jobs, thus, calling for goods and services to meet the needs of those taking the jobs (e.g., homes, food, education) as well as the needs of the recreationists (e.g., lodging, campgrounds, picnic areas, marinas). Some measure of the demand for recreational products and services must be available if future resource requirements for outdoor recreation are to be estimated. (Kalter, 1971)

Only with adequate economic information can sound, objective decisions concerning resource allocation be made.

Recreation Research and the Identification Problem

Previous studies have revealed that many estimates of outdoor recreation demand have used methodologies which do not reflect true supply and demand effects and that this results in the misspecification of the studied demand equation. Often projections of supply needs and demand levels are proven to be invalid due to the indeterminacy of demand and supply functions in outdoor recreation research.

(Seneca and Cicchetti, 1969; Kalter and Gosse, 1969; Cicchetti, et al., 1969)

One of the difficulties involved in the use of the word "demand" when it is applied to outdoor recreation stems from its incorrect application as a description of use or consumption. What is commonly called "demand" in outdoor recreation studies is gross attendance at a facility or actual participation in a particular activity. This does not truly reflect demand, as the word is used by economists; rather, it refers to the quantities taken at the prevailing recreation opportunity conditions. Demand and supply functions each imply a schedule of alternatives (quantities taken or sold at various prices), whereas, use or quantity consumed and quantity supplied refers to a single point on the demand curve and the supply curve, respectively. The intersection of the supply and demand functions at a given time gives the equilibrium quantities.

Use or attendance figures are the net effect of the existing demand and the existing supply and should be recognized as such when they are being viewed for planning purposes. Attempts to isolate these effects encounter the "identification problem," that is difficulties in segregating from certain price-quantity observations the

influence of demand responses and supply responses.[1] Many outdoor recreation researchers ignore the implications of the identification problem. Such ignorance, however, can effect outdoor recreation projections of meaningful future participation rates. The improper accounting of supply considerations leads to the conclusion that people will demand increasing quantities of what they now have, and can enhance further imbalances of facilities. For example, if some areas of the county show greater participation rates for boating than others, and this was taken as a demand statement without the consideration of the availability of boating opportunities, it could lead to decisions to provide even more facilities in areas where such facilities were adequate, rather than providing opportunities in deficient areas.

Economic vs Physical Supply

It is important at this point to discuss the difficult concept of recreational supply and the difference between physical and economic supply. Referring back to basic economic principles, Spencer (1971) defines the concept of supply as "a relation showing the various amounts of a commodity that sellers are willing and able to make

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[1]The demand relationship asserts that as the price of a commodity increases, the quantity demanded decreases, ceteris paribus (i.e., all other factors that could possibly affect demand remain unchanged during the observation period). Similarly, the supply relationship explains that as the price of a commodity increases, the quantity supplied to the market increases, ceteris paribus (i.e., all other factors that could possibly affect supply remain unchanged during the observation period). In reality, prices, quantities and other economic variables all vary simultaneously. When studying their relationships with respect to a specific commodity over a period of time, it is the economist and/or econometrican's responsibility to decide whether the observations made on these relationships reflect demand or supply responses. (Cicchetti, et al., 1969)

available for sale at possible alternative prices during a given period of time, all other things remaining the same." (Spencer, 1971, p. 44) The "all other things" refers to supply being a function of not only the price of the commodity but also the state of technology, prices of resources or costs of the factors of production, prices of substitute commodities, the number of sellers, and a seller's future expectations. This definition, however, is not very meaningful in delineating the supply of outdoor recreation.

Outdoor recreation at a reservoir or the utilization of natural resources has characteristics of a public good due to its "jointness of supply" nature. A "public good" or "free good" (as it is sometimes called) is a good which provides utility for one individual while simultaneously providing utility for other individuals in society at no (or negligible) additional costs (e.g., national defense, police and fire protection). That is, as one person uses or consumes a public good, the amount of that public good available for all other members of society is not reduced. Related to this particular concept of a public good is its "jointness of supply." For example, while providing a reservoir for one individual to swim, the reservoir is also provided for other individuals in society to swim, boat or for water consumption. Consequently, a reservoir is "jointly supplied" to many members of society if it is supplied for one member of society. The additional costs (marginal costs) of supplying the good to additional users is zero (until overcrowding occurs). Thus, outdoor recreation has characteristics of a public good because of the fact that

a facility or natural resource is provided in large invisible lumps. (Cicchetti, et al., 1969)

It is because of its public provision or "jointness of supply" nature that market price is not an explanatory variable in the supply (or demand) for most recreational services. The "commodity" being "purchased" is usually a quantity of user/days taken by the recreationist and some proxy for price, such as time/distance, is used to measure the consumer purchase costs. Looking at it from the producer's (or supplier's) viewpoint, the opportunity cost afforded to the producer (or supplier) of providing an additional unit of output, for example, water-based recreation to a specific multi-purpose project in a specifically defined area at a specified time period is zero or negligible (until it reaches capacity). It is, however, more difficult to conceptualize the supply function on a larger scale (e.g., geographical regions or nationally).

Though a supply function for recreation is difficult, if not impossible to define, certain physical supply considerations, that is, actual physical supply characteristics including acreage, quality, and ancillary facilities, in relation to the demand for recreation are, nevertheless, important. Important in the respect that the physical supply per se, as it affects learning by doing, acts as a demand shifter. Furthermore, the influences of changes in different mixtures of physical supply as well as increases in physical supply on the quantity of recreation consumed can be determined.

Learning By Doing and Boating Demand

Theoretically one would assume that regions with similar characteristics (e.g., socio-economic, demographic, climatic) would display similar demand schedules for boating. This is the expected result if well specified regression estimates for these areas were obtained, i.e., estimates which captured the effect of certain variables including those associated with cultural influences of these areas. If it had been assumed that the supply conditions in each area were identical, then, those areas with similar demand schedules should result in identical quantities being taken or identical attendance. But what if the supply conditions were not the same, would the demand estimates differ in actually? One hypothesis is, yes, the actual demand estimates would differ from the a priori estimates because certain important variables had been omitted from the latter. These variables being the ones associated with the physical availability of water which, it is hypothesized, influence the demand for boating in that they act as a shifter of demand.

This concept can be explained in terms of "learning by doing."[2] People tend not to engage in water based recreational activities if water recreational facilities are neither available nor easily accessible. However, once they participate, their realized enjoyment often exceeds their expectations. As a result, their demand for facilities will tend to increase. Moreover, for the enjoyment of these activities, skill is often required. Skills will not and cannot be de-

[2]This phenomena implies a type of good which is not demanded until supplied. And, is an important aspect of the nature outdoor recreation. (Cicchetti, et al., 1969)

veloped when facilities are not readily available, consequently, there may be little desire to participate in the activities. Opportunities to acquire skill increase if facilities are made available, and user demand tends to rise rapidly overtime as individuals use the facilities and gain skills in the activities. (Clawson and Knetsch, 1966) "The learning process requires a supply to exist and be accessible; therefore, one should a priori expect changes (shifts) in demand to be related positively to changes (shifts) in supply." (Cicchetti, et al., 1969, pp. 50-51) Hence, there are benefits to be derived from learning by doing (a factor related to the supply of facilities).

The above theoretical analysis can further be explained by the following hypothetical example.

Assume, for instance, a public agency associated with the planning and development of land and water resources for the purpose of outdoor recreation is concerned with providing water-based recreational opportunities to a region which originally had no reasonably close water resources available. In the planning process, a demand curve for water-based recreation (D_t) was estimated for the region at a given time period (t). (See Figure 1.) The demand estimate was based on traditional variables such as time/distance (a price proxy), income and other socio-economic variables. User-days was used as a proxy for quantity demanded or taken. From this, as anticipated, benefits of a water project could be determined by utilizing the consumer surplus concept of measuring benefits.

The agency after considering budgetary and physical constraints determined that it would supply amount $\bar{S}$ that would yield $\bar{Q}$ of user-

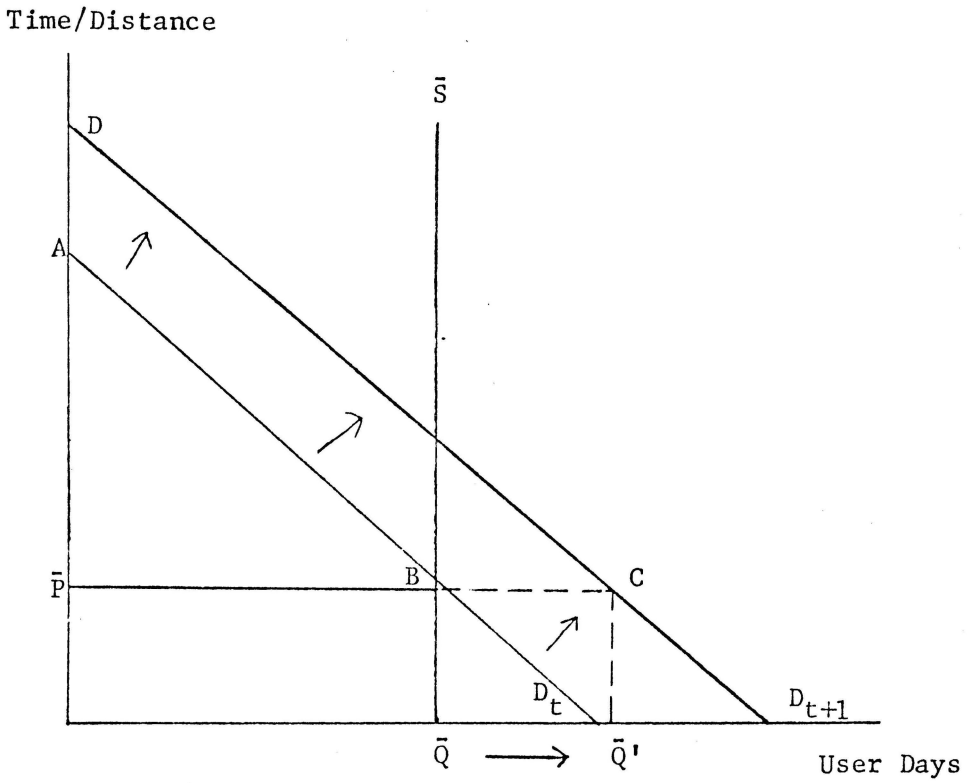


Figure 1. Demand Shifts Associated With the Provision of New Water-Based Recreation Facilities.

days available of a given quality at the associated price of $\bar{P}$.[3] The benefits of providing $\bar{Q}$ amount of user-days to the recreationists would be an expected consumer surplus of $\bar{P}AB$. However, because of the learning by doing process, recreationists have a greater demand for water-based recreation thereby causing the demand curve to shift to the right. Concurrently, at the same price ($\bar{P}$), quantity demanded by the recreationists increases to ($\bar{Q}'$), i.e., more user-days are demanded for the given physical quality of opportunities. The result is an increase (additional benefits) in consumer surplus of ABCD. The original demand curve has underestimated the quantity of user-days demanded, and thus, the benefits (consumer surplus) of providing water-based recreation to the region are also underestimated. Pressure to provide more water-based recreation opportunities of a given quality exists.

Research Objectives

It was discussed earlier that many studies had omitted certain supply considerations, i.e., learning by doing, when estimating the demand for recreation. It is the intent of this study to give some insight into the learning by doing process as it relates to the physical availability of recreational supply, and their effects, if any, on the demand for boating. The underlying assumption is that if these effects can be measured for boating, they can also be measured for other recreational activities. This will be useful in one respect, in

[3]Price includes the average time/distance costs plus any entrance fees collected at the site.

that, it will serve as a basis for providing insight into supply and demand relationships used for project planning, e.g., future trends in activity participation and the adjustment periods of projects. Thus, the following research objectives were formulated.

1. To test the hypothesis: The learning by doing process in relation to the physical availability of water has a significant influence on the demand for boating in ways not captured by the time/distance variable alone, i.e., the learning by doing process as it relates to the physical availability of water is a significant factor in the shifting of the demand for boating even after the time/distance influence has been accounted for.

2. To make inferences as to the effects of learning by doing as it relates to the physical availability of supply on the consumer surplus concept of measuring recreational benefits.

Chapter II will present a review of the research done in the area of recreation demand and benefit evaluation. In Chapter III the boating demand model is presented and the statistical procedure is discussed. A description of the study areas, how they were selected, and the collection of the data is presented in Chapter IV. The boating demand analyses and results are given in Chapter V. The final Chapter VI reports the conclusions made and the policy implications drawn from the study.

CHAPTER II

RECREATIONAL DEMAND AND BENEFIT EVALUATION RESEARCH

Recreation Demand Studies

As indicated previously, in order to achieve an efficient allocation of resources for outdoor recreation, an estimation of the associated demand relationships is required. The development of a generally accepted methodology necessary to estimated recreational demand relationships has been evolving over many decades of research.

Studies dealing with the recreational use of land and water resources date back to 1927. It was not, however, until the 1950's and 1960's that methods for estimating the demand for and value of recreational opportunities were developed rigorously. The National Park Service in 1947 conducted a study to determine the economic benefits of national parks. In a letter to its Director, Harold Hotelling suggested the following procedure:[4]

> "Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of these zones is approximately constant. The persons entering the park in a year, or a suitably chosen sample of them, are to be listed according to the zone from which they come. The fact that they come means that the service of the park is at least worth the cost, and this cost can probably be estimated with fair accuracy. If

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[4]The contents of this letter were taken directly from Brown, Singh and Castle's "An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery," pp. 6-7.

> we assume that the benefits are the same no matter what the distance, we have, for those living near the park, a consumer's surplus consisting of the differences in transportation costs. The comparison of the cost of coming from a zone with the number of people who do not come from it, together with a count of the population of the zone on a demand curve for the service of the park. By a judicious process of fitting, it should be possible to get a good enough approximation to this demand curve to provide, through integration, a measure of the consumers' surplus resulting from the availability of the park. It is this consumers' surplus (calculated by the above process with deduction for the cost of operating the park) which measures the benefits to the public in the particular year. This, of course, might be capitalized to give a capital value for the park, or the annual measure of benefit might be compared directly with the estimated annual benefits on the hypothesis that the park area was used for some alternate purpose.
>
> The problem of relations between different parks can be treated along the same lines, though in a slightly more complicated manner, provided people entering the park will be asked which other national parks they have visited that year. In place of a demand curve, we have a result of such an inquiry, a set of demand functions. The consumer surplus still has a definite meaning, as I have shown in various published articles, and may be used to evaluate the benefit from the park system.
>
> This approach through travel costs is one of several possible modes of attack on this problem. There are also others, which should be examined, though I think the method outlined above looks the most promising."

Implicit to Hotelling's suggestion is that travel (transportation) costs would serve as proxy for price. And, that this price, in conjunction with visitation data, would be a measure of the minimum benefit that people derive from visiting particular recreational sites. (Kalter, 1971; Gilmour, 1973)

Trice and Wood (1958) attempted to implement Hotelling's suggestion. Using data obtained from visitors to three similar areas in California, they computed an average cost of travel per visitor per day. The cost of a recreational value per visitor day for the 90th percentile level and for the median level was obtained from data analy-

sis. Then, by subtracting the median level from the 90th percentile level, a "free value received" benefit was calculated to represent a consumer surplus value. (Trice and Wood, 1958)

As noted by many writers (Hines, 1958; Brown, et al., 1964; Kalter, 1971), there were major weaknesses in the Trice and Wood procedure. One was their assumption that individuals share identical preference scales. Also, the full price-quantity relationship for the site per se was not considered. That is, the methodology used by Trice and Wood approximated a demand relationship with respect to the "whole recreational experience" and not for the facility itself.

Using a framework which has since become widely adopted by economists, Marion Clawson (1959) derived the first important empirical estimates of the demand for and economic value of publicly provided outdoor recreation. Inspired by Hotelling, Clawson's original model was based on a relationship reflecting the transportation costs borne by recreationists taken as a proxy variable for price and the participation rate (visits/population) in outdoor recreation at the site by a given population group. The consumer surplus concept was used to derive the value of recreation to the participant. (Clawson, 1959)

First, a demand curve for the entire recreation experience was computed by plotting the estimated costs per visit as a function of the number of visits per 100,000 population in a given distance zone. Clawson, then, derived a site demand function to get the value of the resource itself. The site demand function related increases on entrance fees to the total number of park visits. Estimates of the

economic value of the recreational site could then be obtained from the site demand function.[5]

There were several limitations to this original analysis. By using distance as a surrogate for monetary costs, except when directly related to such cost figures, the time factor, both for travelling and engaging in the activity was suppressed. This resulted in the demand curves being consistently biased to the left of the actual demand curves. (Knetsch, 1963) Clawson, also, made the unrealistic assumption of homogeneous demand schedules within each distance zone. Zone differences with respect to the distribution of incomes, ages, population densities and other socio-economic variables were ignored. In addition, no consideration was given to the availability of close substitutes or site congestion and other factors influencing the quality of the recreation experience. All of those factors may be important in defining a demand relationship. (Knetsch, 1963; Brown, et al., 1964; Kalter, 1971) Finally, the demand function derived by Clawson was for a specific site, and therefore, it was assumed that a consumers' reaction to costs were constant regardless of the type of cost. That is, Clawson assumed that the all costs of the main trip were borne by the site being considered and that the main purpose of the trip was the visitation of the site. (Kalter, 1971)

There have been many contributions and revisions made with respect to this first analysis. Brown, Singh and Castle (1964) refined the Clawson approach in their economic evaluation of Oregon's salmon

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[5]The methods of obtaining economic values for recreation are discussed later in this chapter.

and steelhead sport fishery. The concentric distance zones surrounding the study recreational area were divided into income-population subclasses, thereby, taking explicit account of income as a demand shifter. An average travel distance per fishing trip was also used as an additional demand determinant. By doing such they were able to approximate the same relationship as Clawson hypothesized for a chosen site. Thus, they were able to compare the economic value computed by the standard Clawson distance zone procedure and the Clawson method with the income and average travel distances used as independent variables. The result was the latter demand estimation technique produced a higher economic value per se than calculated by the standard Clawson approach. (Brown, et al., 1964)

Two methods for estimating demand functions for outdoor recreation were presented by Boyet and Tolley (1966). First, they used states as the units of observation, rather than concentric distance zones to estimate the total number of visits to a facility. The distance from the state to the facility was taken as a proxy for price. Also included in their demand function were the per capita and median values of various socio-economic variables, such as income, age and education for each state. In the second approach, classes of individuals were defined according to unique values of their socio-economic characteristics so that these values would be allowed to have a more pronounced influence on demand. Both approaches were used to project the demand for visits to national parks and a recreation area in North Carolina in 1980. They did not attempt to derive value estimates from their demand functions. (Boyet and Tolley, 1966)

In a pioneering article, Pearse (1968) proposed a method whereby individual recreationists were classified by income classes. The recreationist or hunter (in this case) with the highest fixed cost in a given class was considered the marginal consumer (with a zero consumer surplus). Identical preferences within each class were assumed. Then, by subtracting the fixed cost for each hunter from the cost to the marginal hunter in each class, an individual's estimated consumer's surplus was obtained. An aggregate consumers' surplus value was computed by multiplying the total population of hunters by a weighted average surplus calculated for the entire sample. (Gilmour, 1973)

Brown and Nawas (1973) improved on Pearse's method of using individual recreators rather than the traditional approach of averaging individual observations within distance zones. They showed that distance traveled (a proxy for travel time) could be used more effectively (i.e., without introducing problems of multi-colinearity with variable trip costs) in the demand equation with the more efficient use of individual observations. Hence, an improvement in the specification of the demand model results. This in turn reduced the specification bias of the variable-cost coefficient estimates, and resulted in a larger value estimates for the recreation activity. (Gum and Martin, 1973)

In their study on the demand for and value of rural outdoor recreation, Gum and Martin (1973) were among the first to include substitute attractions in a recreation demand estimation-activity evaluation process. The study also allowed them to use larger numbers of individuals observations, as did Brown and Nawas, so that the distance

variable could be used more effectively in the demand equation. The purpose of basing their analysis on data relating to individuals' total outdoor recreation experiences was that total days of all outdoor recreation data could be used as a shifter variable reflecting tastes and preferences. Thus, by including this variable, constant preferences among recreationists did not need to be assumed. (Gum and Martin, 1973)

The studies dealing with supply considerations are fewer but are continuously expanding. Some of the prominent ones are noted below.

Again by using an expanded Clawson model, Stevens in his article "Recreation Benefits from Water Pollution Control," according to Kalter, (1971) attempted to show the relationship between recreation benefits and the quality of water. His thesis was that a change on water quality would result in a change (shift) in the demand schedule for a specific water recreational activity. In essence, the study revealed that quality considerations should be taken into account when using demand estimates for projection purposes. (Kalter, 1971)

Davidson, Adams, and Seneca (1966) introduced an intertemporal relationship, the "learning-by-doing" concept, into outdoor recreation literature. As implied previously, this concept is based on the idea that <u>if</u> facilities are available, individual consumers in time period t_1 would learn or develop a demand for a recreation activity which would result in an increase in their demand in time period t_2. Moreover, through social interaction, the demand of their families and associates may increase in t_2 as well. Davidson, <u>et al.</u>, concluded that benefits could, indeed, be afforded by the learning by doing process.

Continuing this thought, according to Cicchetti, et al., (1969) Seneca, in his study "A Generalized Approach to Estimating Recreation Benefits," found that changes in the supply in the previous year (t-1) explained participation in the present year (t) better than supply changes in the present year. A higher correlation between demand and supply lagged one year is indicated. And, "this a priori and a posterior evidence leads us to suppose that shifts in both curves are positively related and supply in period (t-1) is a causal factor in determining demand in period (t)." (Cicchetti, et al., 1969, p. 50)

Cicchetti, Seneca and Davidson in their study The Demand and Supply of Outdoor Recreation (1969) present an excellent assessment of the problem incurred in estimating the demand and supply of outdoor recreation. Supply considerations, in particular, are given much needed attention. In their study, Cicchetti, et al., use a two step procedure first to determine the probability of participation in recreational activities and, then, to examine the variables that determine the extent of participation for those who did participate. What resulted was the derivation of "reduced form" equations which took into account both supply and demand variables. The supply variables reflect a composite of the level of crowding measured as acres per recreationist (a quality variable) and the relative availability of recreational resources measured as acres per capita (a quantity variable) in a time period (t-1). The demand variables included certain socio-economic variables in time period (t) and distance (t-1) (measured as the physical distance between the ith individual's point

of origin and a major body of water) is used as a proxy for price lagged one period.[6]

Seneca and Cicchetti (1969) attempted to "identify the influence of production-type variables on outdoor recreation activity." (Seneca and Cicchetti, 1969, p. 238) They argued that many previous recreation research studies dealt only with estimating recreation "demand" and no consideration was given to evaluating the influences of the supply or production side of recreation. A user response function was developed in their study as a quantitative relation between the quantity of recreation visits to a site and the physical facilities of the site. They proposed that this function could produce quantitative estimates of the number of recreation visits, and thus, aid in the stimulation of various recreation policy alternatives.

In a recent article, "Some Implications of the 'New Theory of Consumer Behavior' for Interpreting Estimated Demand Elasticities," Hogarty and Mackay (1975) provide a framework for relating the above theoretical considerations to the basic model formulation presented in the present study. The modern economic theory of consumer behavior, as suggested by Lancaster (in the Hogarty and Mackay article), reveals that the household's decision making process operates under two stages, production and consumption. In the production stage, commodities are used as inputs into the production process whereby the household, "given its knowledge of the production process determines the input combinations that produce a given level of the ith commodity

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[6]For further discussion, see Cicchetti, et al., The Demand and Supply of Outdoor Recreation, (1969), pp. 53-86.

at least cost for given input prices." (Hogarty and Mackay, 1975, p. 341) In order to maximize utility subject to its budget constraints, the household, in the consumption stage determines the levels of the commodities produced. Combining these two stages, "by substituting the demand functions for the produced commodities, derived in the consumption stage, into the constant output demand functions for inputs, derived in the production stage," household derived demand functions for market goods can be formulated. Thus, in relation to recreation, the derived demand function for a recreational experience such as boating would theoretically be dependent upon household tastes for boating, prices and income. Further, as suggested by Hogarty and Mackay, large increases (decreases) in prices resulting from technological changes in the production function may cause these derived demand functions to shift. Therefore, a large price decrease resulting from the addition of a new reservoir (new boating opportunities) has the effect of shifting the demand curve for boating to the right. This is the result of a change in the existing production technology for boating as known by the household caused by a change in the state of the arts, i.e., learning by doing.

The present study is a combined analysis of the influence on the demand for boating of (1) the physical supply available represented by the actual physical characteristic of certain reservoirs, and (2) the learning by doing process represented by the physical quality index and lagged dependent variables. A demand equation is formed including these physical supply factors from which an added measure of the benefits resulting from them is obtained. The improved information on

physical supply factors, in relation to demand, afforded by this study will allow present and future planners to assess more accurate values for water projects or any project which is considered for recreational use.

Approaches to Economic Value Estimates

In recent years, public agencies have concentrated on quantitative or objective analysis of the consequences of available alternative projects and policies. For instance, in evaluating the relative desirability of water resource development projects, benefit-cost analysis has been used. Generally, the beneficial effects of water resource development projects have been related to the purposes of hydropower, flood control, navigation, and irrigation. These purposes are recognized in dollar value terms and comparisons are made in the costs of providing them. (Clawson and Knetsch, 1966) With the passage of Senate Document 97, the demand for and evaluation of benefits from recreation became an important factor in water resource development. Earlier in this chapter, a review of methods, theoretical considerations, and problems involved in recreation demand estimation were discussed. The determination of the implications of such estimation to the evaluation of recreation benefits is extremely important, however, if the requirements of Senate Document 97 are to be met.

The primary problem faced in dealing with recreation as a valuable output of resource use is a measurement problem. Expressions of the economically meaningful values which might be imputed to resources

used for recreational purposes are not clear. (Clawson and Knetsch, 1966)

As previously referred to, outdoor recreation has centered largely on publicly owned and controlled areas. It has developed essentially as a non-market commodity and thus, readily available prices to guide the allocation of resources in the desired directions are absent. This necessitates the reliance on indirect means to provide relevant measures of the values of recreation services produced. (Knetsch, 1964)

Measures of economic value are based primarily on what people are willing to give up. Willingness to pay on the part of consumers of outdoor recreation services is, therefore, one relevant economic measure of recreational values. The opportunity for ascribing relevant values to resource used for recreational opportunities is provided by these measures being analogous and comparable to the values which would be reflected if an organized market existed. The value of the product of a resource use is related to a demand schedule which measures the willingness to pay (defined as the entire area under the demand curve or consumer surplus market value) on the part of the consumers for the benefits afforded. (Knetsch, 1964; Kalter, 1971)

Two methods appear to offer reasonable means of obtaining meaningful estimates of willingness to pay (for a site). The first is by using travel cost data and the second by a direct interview method.

The Clawson method discussed earlier can serve as a basis for the derivation of travel cost value estimates. Recalling that this method uses travel cost data as a proxy for price, a demand function

for the recreational site is computed. From this demand function, value estimates can be determined. This method is shown by using the simple hypothetical example presented below.[7]

Assume a given recreation or park area at varying distances from three population centers. Also assume that the entrance fee to the recreation area is zero, thus, travel costs become a major concern of potential visitors. The costs of visiting the area, including such things as transportation, lodging and food cost above those incurred had the trip not been made, can be assumed to vary with the distance from the population center under consideration to the recreation area. Table 1 describes this hypothetical demand situation.

The demand curve for the whole recreational experience is derived by relating the number of visits per 1000 population for each zone to simulated increases in cost per visit. The expected result of an increase in cost per visit to the area from each of the different zones is the reduction in the number of visitors coming from each of the zones. This relationship is graphed in Figure 2.

The demand curve for the recreational site itself is, in turn, derived from the demand curve for the whole recreational experience. As indicated by Table 2, when no entrance fee is required, 2400 visits would be taken. This delineates the first point on the site demand curve, that is, the quantity demanded at a zero price. Assuming a $2 entrance fee, the total cost per visit from each distance zone would increase by this amount. Such an increase, it is expected, would cause

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[7]This example is taken from the one presented in Kalter (1971) pp. 28-32 and pp. 82-83.

Table 1

Visits to a Hypothetical Recreation Area

City	Population	Cost of Visits	Visits Made	Visits/1000 Population
A	2000	$2	800	400
B	4000	6	800	200
C	8000	8	800	100

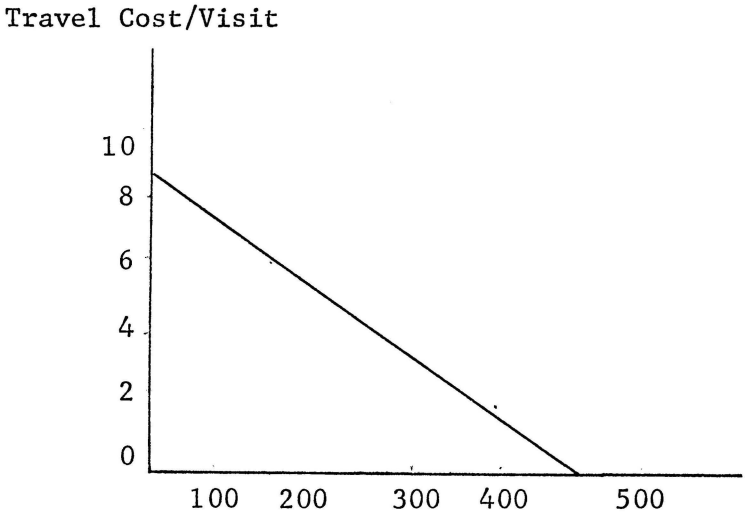


Figure 2. Hypothetical Demand Curve for the Whole Recreational Experience (Assuming Zero Entrance Fee).

Table 2. Effect of Increases in Cost on Numbers of Visits to the Hypothetical Recreation Area.

Distance Zone	Number of Visits at Added (Entrance) Cost Per Visit of:			
	$0	$2	$4	$6
A	800	600	400	0
B	800	400	0	0
C	800	0	0	0
Total Visits	2400	1000	400	0

a reduction in the number of visits from each distance zone. The amount of such a reduction can be estimated from the original cost-visit relationship. For example, the original (travel) cost per visit from Zone A was $2 with the number of visits being 800. An added increase in cost of $2 would make the total cost $4 and would result in a decrease of visits to 600. Likewise, with a $2 cost increase, the number of visits in Zone B decreases to 400 and in Zone C it drops to zero.

Therefore, total visitation is reduced to 1000 visits for an entrance fee of $2. Likewise, 400 total visits is the expected result of an increase to $4 per visit while visitation would be reduced to zero with a $6 entrance fee. This demand relationship is plotted in Figure 3 which shows the demand curve for the hypothetical recreational site.

Then, the total willingness to pay by consumers can be estimated as the sum of the maximum prices which various consumers would be willing to pay for various quantities of recreation output.[8] Using 400 recreation visits, valued by those who participate at between $3 and $6 per visit, a total value of $1800 (400 times $4.50 is computed). Another 1000 visits valued between $2 and $3 would yield a total value of $2500 (1000 times $2.50). Finally, 2400 would be valued at between $0 and $2 yielding $2400 ($1 times 2400). The approximate measure of the gross economic value per unit of time is computed as $6700, by summing these values. The limitations of using this method were discussed in the previous section.

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[8]This value is the total area under the demand curve.

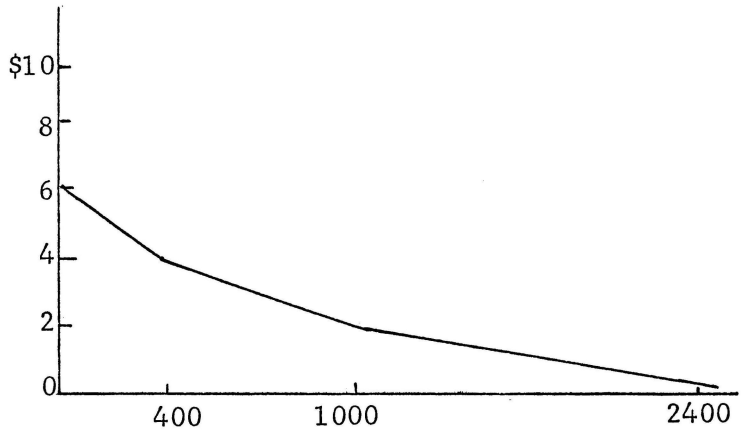


Figure 3. Hypothetical Site Demand Curve.

The basis of the interview method of measuring recreation benefits is that if a properly constructed interview was conducted, one could collect and evaluate information concerning the maximum price recreationists would be willing to pay for certain recreational services rather than forego them entirely. The theory behind the existence of something to be measured rests on the idea that the recreationist attempts to maximize his utility and makes a rational series of allocations of time and money in order to participate in the recreation opportunity being evaluated. Because the opportunity itself is available at a zero or nominal price, the interview can provide the means for determining the price the individual would pay if this opportunity were marketed, ceteris paribus. (Knetsch and Davis, 1966)

The major problem with using the interview method is the degree of reliability that can be attached to the information the respondent provides the interviewer. The responses may be subject to many kinds of bias. One such bias is that the respondent may underestimate his preference for the commodity, thinking he will avoid being charged as much as he is willing to pay without being deprived of the amount of goods he now desires. Conversely, another respondent may overstate his preference in order, for example, to help preserve an area in its current use. These bias may be partly resolved by phrasing questions in such a way as to not ask for the respondent's opinion. However, there are some disadvantages of using this method, such as generalizing the results to wider and proposed areas. Also, the costs of obtaining the needed information are high. (Knetsch and Davis, 1966)

A number of alternative methods for measuring or estimating recreation values have been proposed and to some extent used. Some of the following measures are theoretically faulty and others invalid on empirical grounds in that they fail to measure appropriate values. The failure to identify the relevant produce causes part of the difficulty.

One approach used by the National Park Service from 1950 to 1957 was the "cost" method. This method equates the value of outdoor recreation use to the cost of generating it. That is, for example, "...A reasonable estimate of the benefits arising from a reservoir may be normally considered as an amount equal to the specific costs of developing, operating and maintaining the recommended facilities." (National Park Service, 1950) This has the effect of economically justifying any proposed recreation project on the grounds that benefits equal costs. This method offers no guide in evaluating a contemplated loss of recreation opportunities. Also, it allows little discrimination between the relative values of alternative investment opportunities. (Clawson and Knetsch, 1966; Knetsch and Davis, 1966; Gilmour, 1973)

The market value method is yet another approach. A schedule of charges representing the market value of the recreation services produced is the basis for measuring recreation benefits by the market value method. Actual or expected attendance figures are multiplied by those charges to obtain the recreation value for services. The market value selected is normally related to the prices charged at privately owned recreation areas. (Clawson and Knetsch, 1966; Knetsch and Davis, 1966)

This method is one of the most common methods used for measuring recreation benefits at public recreation areas. Federal agencies involved in the construction of recreational facilities have utilized in the past and are continuing to use this method. (Kalter, 1971) It is, however, subject to some limitations. The method seems appropriate for its emphasis on the willingness of users to incur expenses but it seems somewhat inappropriate to use the charges at private areas to measure the value of recreation at public areas. Private recreation areas are affected by the "free" public recreation areas. Private areas are not fully comparable with public areas in that users are willing to pay fees or charges. Because of this the charges that users are willing to pay at private areas may largely reflect payments for benefits in excess of those available at public areas, e.g., better natural resources, better management, less crowding. Also, a single value figure or some range of values will be inappropriate for many recreation areas. Physical units of goods and services are not equally valuable everywhere, as in the case of recreation, location affects the value greatly. (Clawson and Knetsch, 1966; Knetsch and Davis, 1966)

The last approach to be discussed is the gross expenditures method. The measure of the value of recreation to the recreationist in terms of the total amount spent on recreation by the user is the idea behind the gross expenditures method. That is, recreation to the recreationist is worth at least as much as he/she is willing to pay for it. Travel expenses, equipment costs, and expenses incurred while at the recreation area are among the expenditures estimated. The estimates of gross recreation expenditures tend to produce large fig-

ures, however. Hence, they give the impression of large and profitable tourist-recreation businesses. (Kalter, 1971; Brown, et al., 1966) A number of agencies, e.g., state fish and game departments, travel departments, use this method. They contend that the value of a days recreation is worth at least the amount of money spent by an individual for that purpose. (Kalter, 1971)

As justification for public expenditures on recreation or for determining the worth or benefit of the recreation opportunity afforded these values are of little consequence. They are useful in indicating the amount of money spent on a particular type of outdoor recreation. What is needed, however, is the net increase in value over and above what would occur in the absence of a particular type of outdoor recreation opportunity, not a gross value. The value of the losses (or net gains) sustained if a particular recreation opportunity were to disappear (or increase) are not reflected in gross expenditure. (Clawson and Knetsch, 1966; Knetsch and Davis, 1966)

As evidence by the foregoing review, the willingness to pay methods is the most relevant approach to the evaluation of economic benefits of outdoor recreation. Willingness to pay values do not, however, include two types of demand which may or may not be important. These are option demand and demand generated by the opportunity effect.[9] Option demand is that demand from individuals who are not now consumers or are not consuming as much as they anticipate consuming, and who would, therefore, be willing to pay for the "option"

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[9]These concepts are developed more fully in the study done by Davidson, et al., (1966), pp. 183-186.

of using recreational services in the future. The opportunity effect reflected by unanticipated increases in demand is caused by improving the opportunities to participate in recreational activities and thus, acquainting consumers with new and different opportunities to which they adapt through the learning process. (Davidson, et al., 1966; Knetsch and Davis, 1966) It is precisely this opportunity effect, that is, the effect on recreation demand of learning by doing as measured by physical supply, which is investigated in this study.

CHAPTER III

THE BOATING DEMAND MODEL

Model Identification

Theoretically, the demand for a good or service is a function of (1) the market price of the good or service; (2) the buyers' tastes and preferences; (3) the buyers' socio-economic characteristics (which can affect tastes and preferences); and (4) the availability and costs of alternative goods and services. The demand curve, once developed, represents a relation of the various quantities of a commodity that buyers would be willing and able to purchase at possible alternative prices during a given period of time, ceteris paribus.

As indicated in the previous chapter, market price is not an explanatory variable in the demand for (or supply of) recreational services because of its public good nature. Therefore, the "commodity" being "purchased," say, quantity of user-days taken by the recreationist can be assumed to be a function of some proxy for price that measures the consumers purchase costs. That is, the demand for outdoor recreation, is assumed to respond to the same factors that influence the demand for other goods and services in society. Thus, as suggested in Chapter II, outdoor recreation demand is a function of some proxy price variable (e.g., total or average travel costs, actual distance,

or time/distance); income and other socio-economic variables such as age, sex, education, family composition; substitute prices, and various supply characteristics of the recreation area such as quantity, quality, and the learning by doing factor. Some of these factors can be empirically measured easily while others cannot. The latter are subject to the interpretation of and specification by the researcher. Yet, despite the differing empiricizations of the various variables in previous studies, all the factors mentioned above have been shown to be statistically related with the "demand" for various types of recreation. (Trice and Wood, 1958; Clawson, 1959; Knetsch, 1963; Brown, et al., 1964; Boyet and Tolley, 1966; Davidson, et al., 1966; Pearse, 1968; Cicchetti, et al., 1969; Seneca and Cicchetti, 1969; Kalter and Gosse, 1969; Kalter, 1971; Brown and Nawas, 1973; Gum and Martin, 1973)

In the basic demand equation for boating represented in the present study, boating demand is a function of the independent variables: time/distance, certain socio-economic variables, an index of certain factors reflecting the physical capacities and facilities of reservoirs, and a lagged dependent variable. The relationship is thought to be:

$$D_B = f \text{ (Time/Distance, Percentage of Population (25 and over) Who Completed High School or Better, Percentage of Families Earning the Equivalent of \$9000 or More in 1974 Dollars, Physical Quality Index, Lagged Dependent Variable)} \quad (3.1)$$

Boating Demand

Dependent Variable: The conventional measures of use, the recreation quantity unit, is characterized by a lack of rigor in defini-

tion. The choice of a unit of recreation becomes a choice among quantity proxies in terms of some quantifiable characteristics. (Jennings and Gibbs, 1974; Kalter, 1971) The number of visits has been used as a quantity variable in many outdoor recreation demand studies. As mentioned previously, Clawson (1959) used the number of visits per population zone as his quantity variable. More recently, Brown and Nawas (1973) used the quantity proxy of the number of visits per capita in their study. Since recreationists react to prices or costs by adjusting both their number of visits and their length of stay per visit, it has been suggested that the total quantity of recreation demanded be measured in terms of time (seasonally or annually). (Jennings and Gibbs, 1974; Kalter, 1971) Thus, one quantity proxy would be annual user (or recreation) days.[10] McConnell (1975) argues, however, that "deriving the (recreation) demand functions from a utility maximization framework demonstrates that user-days are not an appropriate measure for the quantity of recreation demanded when using the travel cost method." (McConnell, 1975, p. 332) That is, specifying the demand for user-days as a function of travel costs is not consistent with utility theory, in that, in many cases the marginal cost of a user-day is independent of the level of travel costs. And, therefore, making inferences about consumers' surplus, assuming that travel costs are the marginal costs of a user-day, could lead to biased estimates. McConnell further suggests that a relationship between trips and travel costs provides a more meaningful basis for the derivation

[10]A user-day is defined, here, as a visit by an individual, family unit or any other decision-making unit of persons to a recreation area for recreational purposes during a 24 hour period.

of recreation demand functions from which measures of consumers' surplus can be determined.

In this study, however, it is assumed that a user-day provides the best quantity measure for estimating boating activity demand because boaters tend to make the boating trip on a daily basis, thus their unit cost of a user-day will indeed be approximated by travel cost to the site. Based on a relationship between user-days (or some proxy thereof) and time/distance (a price proxy), a demand function for boating can be derived and from which a measure of consumers' surplus can be inferred. Therefore, in the demand equation for boating presented here, the quantity of boater registrations per 1000 households variable is used as a proxy for annual user-days, with the underlying assumption that the two are well correlated, i.e., as the quantity of boater registrations increases per household so do annual user-days.[11]

Time/Distance Independent Variable: One of the most important factors in the demand function for any good or service is the price or cost of that good or service to the consumer. Since prices are not easily defined for recreational opportunities, price proxies are used to reflect variation in the recreationist's opportunity cost of recreation at a particular site. (Jennings and Gibbs, 1974; Kalter, 1971) Transportation or transfer costs, in terms of time and distance of travel, meals and lodging, and distance alone are but two types of price proxies used in recreation studies. (Clawson, 1959; Boyet and Tolley, 1966) McConnell (1974) asserts that though it is widely ac-

[11]This assumption is discussed further in this chapter.

cepted that the traveling time to a recreation site is an important cost variable, total time required for completing the recreational activity, including time in transit, should be considered in the estimation of demand functions. To ignore this time value would be to bias demand downward and underestimate consumer surplus benefit values. (McConnell, 1974)

Another type of price proxy, the one used in this study, is one which reflects the value of the recreationists' time and distance of travel to the recreation site under consideration. Since distance traveled and traveling time are usually highly correlated, it is difficult to separate the effect of one from the other. Thus, it is assumed that the actual time value, in hours, that it takes to reach a recreation area is directly related to the distance traveled to that area from the point of origin. The time/distance variable described in this study is an average total cost of traveling to a reservoir area for the purpose of recreational boating in terms of distances traveled from the center of the most populated areas (major cities) in the counties under observation to the study reservoir assuming a 55 mph speed limit; average retail gas prices; and average miles per gallon of gasoline.

Socio-Economic Independent Variables: As an element in the demand for outdoor recreation, or any other commodity, tastes and preferences are difficult to measure or quantify. Individuals' tastes and preferences are, however, positively correlated to their socio-economic status as many sociological and psychological studies have indicated (according to Kalter and Gosse, 1969). In turn, there are

many factors (e.g., age, sex, education, income, family composition) which have been associated with changes in recreation demand; these are measurable and can be used to define an individual's socio-economic status. (ORRRC, Study Report 26, 1962; Brown, et al., 1964; Boyet and Tolley, 1966; Kalter and Gosse, 1970) Assuming, as generally accepted, that groups of individuals who have similar socio-economic characteristics tend to have a common outlook on life, socio-economic variables have value in predicting the actions of consumers. Thus, demand is considered a partial function of these variables.

Two socio-economic variables: The percentage of the population 25 and over who completed high school or better and the percentage of families earning the equivalent of $9000 or more in 1974 dollars, were assumed a priori to have a substantial effect on the demand for boating, i.e., the more educated and the more income a family earns, the more likely they are to purchase and maintain a boat(s).[12]

Physical Quality Index Independent Variable: To restate, the main objective of this study is to determine if the physical availability of supply as it affects the learning by doing process influences the demand for boating in that it acts as a demand shifter. One way to approach this was to develop an index of certain factors reflecting the physical capacities and facilities of the reservoirs studied to capture any shifting (of demand) effects. The index is composed of the number of shoreline miles available for recreational

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[12]Two other variables, the percentage of the population age 25 or older and the percentage of urban population, were also considered but were disregarded in the final analysis due to their lack of statistical significance.

use, the reservoir size in water surface acres, the number of boat ramps and marinas, and the number of camping and picnic areas. Other characteristics associated with the reservoirs, e.g., the length of the recreation season and the maximum change in the fluctuation of the reservoir pool, were also considered but were not included in the index due to their lack of variability over many of the years of study.

The number of shoreline miles available for recreational use and the reservoir size in water surface acres define the capacity or the actual physical supply of the reservoir being observed.

One factor which also has an effect on the demand for any good or service is the availability and costs of alternative goods and services. Of particular concern here, are the alternative recreational activities which are compliments or substitutes to the boating activity. Identifying the costs and the availability of these activities would be useful in determining the influences of such factors on the demand function for boating. Some complimentary activities for boating might be waterskiing, swimming, or picnicking while camping, golfing, hunting are among those considered to be substitute activities. It was assumed in this study that most of these activities would have an insignificant effect on the annual demand for user-days of boating for the study areas.[13] The two activities considered to have the most effect on boating demand are picnicking and camping at the site and were, thus, represented in the index by the actual number of picnic and camping areas. Not including the other substitute activities in

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[13] A description of the study areas is presented in the next chapter.

the index would, if they were indeed significant, probably bias the coefficient on the physical quality index and time/distance variables.

In the above discussion compliment and substitute recreational activities for boating were presented. A discussion of a second factor of importance, the availability of close substitutes for the study reservoir areas themselves, in estimating the demand relationship for boating is necessary at this point. The importance of substitute reservoir areas increases with increases in distance from the study reservoir area under consideration to the point (county) of observation. It has been suggested by Knetsch (1963) that knowledge of alternatives, their location, size and quality is needed in the demand relationship for any recreational area so as to reflect their (the area's) availability and opportunity costs to the recreationist. Thus, the closest alternative reservoir area(s) to the sample observations in each study are included in the demand for boating for that study area in the physical quality index independent variable.

In the cases where the physical capacities and the number of facilities did not change over the years except when the new reservoir projects were completed, an index variable, if developed, would have the same effect as a dummy variable. Therefore, a 0-1 dummy variable, which it is assumed will react in a similar manner as the index variable, is used to represent the physical supply factor in the demand equation for boating.

Lagged Dependent Variable: The lagged dependent variable, used in conjunction with the index variable, represents the time trend corresponding to the learning by doing process in its relation to the

physical availability of supply. Both variables are assumed to reflect some learning by doing effect. In keeping with the assumption made in Chapter I that supply in period t-1 is a positively correlated factor in determing demand in period t, it is, therefore, expected *a priori* that as more water resources and more facilities are developed for recreational use in time period t-1 the demand for and participation in boating activities will increase in time period t.

Statistical Procedure

The main statistical procedure used in this study is an ordinary least squares regression analysis of combined time-series and cross-section data. The principal objective of the least squares regression procedure is to obtain a least squares estimator for each explanatory variable in the demand equation. These estimators are referred to as least squares because they minimize the sum of the squared deviations from the regression line. That is, the computed regression coefficients minimize unexplained variance in the regressional model. (Hu, 1973)

The combined time-series and cross-sectional approach to data analysis pools the sample observations for the same (homogeneous) economic units over several (homogeneous) time periods. And, thus, should be richer in data (information) than either time-series or cross-section data alone. (Hu, 1973) Time-series data are obtained for the same economic unit (e.g., county) over many points of time such as monthly or annually. Cross-section data, on the other hand, are obtained on the activities of an individual economic unit (e.g.,

county) for a given period of time. In short, in the analysis of time-series data, different time periods are assumed homogeneous except for random disturbances and changes which can be analyzed within the model, whereas, different consumers or sample persons are assumed homogeneous except for random disturbances and changes which can be analyzed within the model in the analysis of cross-section data. (Hu, 1973; Kalter and Gosse, 1970)

The combined data approach was taken in order to capture the influence of the physical supply and learning by doing variables among a cross-section of homogeneous observations (counties) over time, something a time-series or cross-sectional analysis alone could not do.[14]

A principal component analysis method is, also, used to form the physical quality index. This method combines variables by an additive weighting system so as to create a new combination (index) variable. This newly formed variable captures the largest percentage of variation in the entire data set as is possible, that is, "the first PC (principle component) is the linear function of all variables that maximizes the sum of the squares of each variable with the PC." (Batie, 1974, pp. 1-2)The index variable was developed and used to capture, in one variable, an estimate of the entire physical quality

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[14]Some limitations exist when using this combined data approach. Except for the household-survey data, most time-series or cross-section data are aggregate in nature, i.e., the economic unit is defined in terms of national, state, county, or industry units. Economic theories, however, are formulated from analysis based on individual's or single firm's behavior. The results from aggregated data, therefore, do not depict the results of a single individual's or firm's behavior exactly. (Hu, 1973)

aspect of the reservoir area being studied. The purpose of the analysis to follow is in part to determine the effect on boating demand estimates of the factors relating to a reservoir's physical quality as a whole not each individual aspect separately. Also using the index variable reduces the number of degrees of freedom in the equation and the statistical problems associated with a large number of degrees of freedom.

CHAPTER IV

RESERVOIR STUDY AREAS AND DATA COLLECTION

Nature and Description of Study Areas

To conduct this research study, using the approach suggested in Chapter III, certain a priori requirements for the study areas had to be met. First, the actual numbers of registered boats by county were needed to provide a framework for analysis. Agencies dealing with boat registration in several states were contacted to determine if their (the states') boat registration data were "compatible" with one another with respect to the collection of boat registrations by counties, the types of boats registered, and how and when the boats are registered.[15] Also, it was determined whether or not this type data could be obtained by the public in a usable form. Of the states contacted, two, Virginia and West Virginia, met the requirement of compatibility. Thus, the number of registered boats by county were obtained from the Virginia Commission of Game and Inland Fisheries for the years 1960-1973 and from the West Virginia Division of Water Resources for the years 1963-1974.[16]

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[15]"Compatible," here, means that each observation needs to be homogeneous with respect to the type of boat registration data, so that similar study areas could be defined.

[16]These time periods correspond to the limited amount of boat registration data available within each state.

Second, the reservoirs to be studied were to be selected according to their project completion data. That is, each reservoir project had to have been completed and opened to the public for recreational use within the aforementioned time periods. This requirement was necessary in order to assure that enough time would have elapsed before and after the project was completed to allow the independent variables to vary and the dependent variables to vary with respect to the influence of the changing independent variables in the mode. Three reservoir projects met this requirement: Leesville-Smith Mountain Lake in Virginia and, Summersville and East Lynn in West Virginia.

The Leesville-Smith Mountain Lake project was started in 1960 with Leesville Reservoir (the lower portion) completed in 1964 and Smith Mountain Lake (the upper portion) completed in 1967. The project was developed under the auspices of the Appalachian Power Company for the main purpose of hydro-electric power and storage, but recreation became an added use and benefit. In southwest Virginia, the project is located on the Roanoke (Staunton) River, at the point where the counties of Bedford, Campbell, Franklin, and Pittsylvania meet. The reservoirs have a combined area of 24100 water surface acres with 510 miles of shoreline. Recreational activities provided by the lakes and surrounding land areas include boating, camping, fishing, picnicking and swimming. There is, also, a wildlife refuge and hunting preserve.

The Summersville Lake project grew out of a desire for additional flood protection and expanded water resource benefits including recreation. The benefits from flood control are realized primarily in

the Kanawha River basin. Under the supervision of the U.S. Army Corps of Engineers, the project was begun in 1960 and ready for public use by 1966. It is located on the Gauley River near the town of Summersville in Nicholas County, in the eastern part of West Virginia. Summersville Lake has 65 miles of shoreline and 2723 acres of water surface. In addition to fishing, boating and waterskiing, there are facilities for picnicking and camping and open wooded areas for hiking or browsing.

In the western part of West Virginia, the East Lynn Lake is found on the East Fork River in Wayne County just 31 miles south of Huntington. Also a governmentally owned and controlled Lake, the East Lynn project was started in 1968 and was providing benefits of flood control, fish and wildlife habitation and recreation to the public by 1972. It has an area of 1005 water surface acres with 46 miles of shoreline. Boating, waterskiing, swimming, fishing, picnicking and camping are among the recreational opportunities provided by East Lynn Lake.

As stated earlier, the availability of close substitutes for the study area is an important factor in estimating the demand relationship for boating. Thus, the closest alternative reservoir area(s) to the sample observations in each study area are included in the demand for boating for that study area. To do this, the same type of data was collected for the alternative reservoirs as was for the study reservoirs for each of their respective study year periods. Then, the reservoir data for each substitute reservoir before and the substitute

and study reservoirs after the latter were completed was aggregated across the reservoirs for each consecutive year.

Further, when using any time-series data a measure of the price variable, i.e., time/distance, is needed on the sample observations (counties) before the study reservoirs were completed. Therefore, the closest alternative reservoir to the sample observations also provides the basis for measuring this data.

In Virginia, the closest alternative reservoir chosen for the Leesville-Smith Mountain Lake project is Philpott Lake. Philpott Lake is a flood control and hydro-electric power project of the U.S. Army Corps of Engineers. Construction on the project was begun in 1949 and completed in 1953. The lake is found in Southwest Virginia on the Smith River where Franklin, Henry, and Patrick counties meet. The reservoir is comprised of 2880 water surface acres with 100 miles of shoreline. Recreational opportunities provided by the reservoir area include boating, waterskiing, swimming, and skin diving as well as camping, picnicking, sightseeing, and hunting.

In West Virginia, both Summersville and East Lynn projects share two of the same alternative reservoirs - Bluestone and Sutton Lakes. Summersville Lake, when it was completed, became an additional alternative for the East Lynn project. All three alternatives are used because one reservoir could be considered closer to one county observation point than another in the same study area. Both Bluestone and Sutton Lakes are projects under the management and control of the U.S. Army Corps of Engineers. Bluestone Lake, located on the New River in Summers County in Southeastern West Virginia, was completed in 1949.

It has 33 miles or shoreline with an area of 2040 water surface acres. Sutton is in the Northeastern part of the state on the Elk River in Braxton County. The project was completed in 1961 and has an area of 1520 water surface acres with 40 miles of shoreline. Both alternatives afford the same type of recreational opportunities such as camping, picnicking, hiking, boating, fishing and swimming.

Finally, the study areas were defined according to the reservoir project and a cross-section of counties surrounding them. The counties were selected on the basis of their proximity to their corresponding study reservoir and to avoid the complications that may arise from the effects of too many alternative reservoirs found in one study area. The counties, also, aide in the identification of the sample observations (i.e., the number of boater registrations by county per 1000 households over a period of several years).

The Leesville-Smith Mountain Lake study area in Virginia encompasses the project itself and the counties of Bedford, Botetourt, Campbell, Franklin, Henry, Patrick, Pittsylvania, and Roanoke. The independent cities of Bedford, Danville, Lynchburg, Martinsville, Roanoke and Salem are incorporated into their corresponding counties, for data purposes, according to location, i.e., Bedford City in Bedford County; Lynchburg City in Campbell County; Martinsville City in Henry County; Danville City in Pittsylvania County; Roanoke and Salem Cities in Roanoke County.[17]

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[17]This was necessary so that the census data used for the counties in both states would be of a similar nature. The counties and cities in Virginia were listed independently, in West Virginia they were not.

In West Virginia, the counties of Braxton, Clay, Fayette, Greenbrier, Kanawha, Nicholas, Pocohontas, and Webster and Summerville Lake comprise the Summersville study area. The East Lynn study area is composed of East Lynn Lake and the counties of Boone, Cabell, Kanawha, Lincoln, Logan, Mingo, Putnam, and Wayne. All major cities in West Virginia were already incorporated in their respective counties.[18]

These three study areas, including the alternative reservoirs, appear in Figures 4, 5 and 6.

Data Collection

Once these requirements were met and the study areas defined, data on the reservoirs themselves and the counties were then collected and analyzed.

Recall in the demand equation for boating, the dependent variable, the quantity of boat registrations per 1000 households, is used as a proxy for annual user-days. To obtain this figure, the number of households for each consecutive year during a given study period was needed. Limited by secondary data sources, a growth rate for each county was computed using actual 1960 and 1970 census figures for households and the formula:[19]

$$P_n = P_o\ (1+r)^n \qquad (4.2)$$

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[18] See footnote 17.

[19] This formula was taken from Applied General Statistics, Craxton and Cawden (1955), pp. 201-203.

1. Leesville-Smith Mountain Lake

2. Philpott Lake

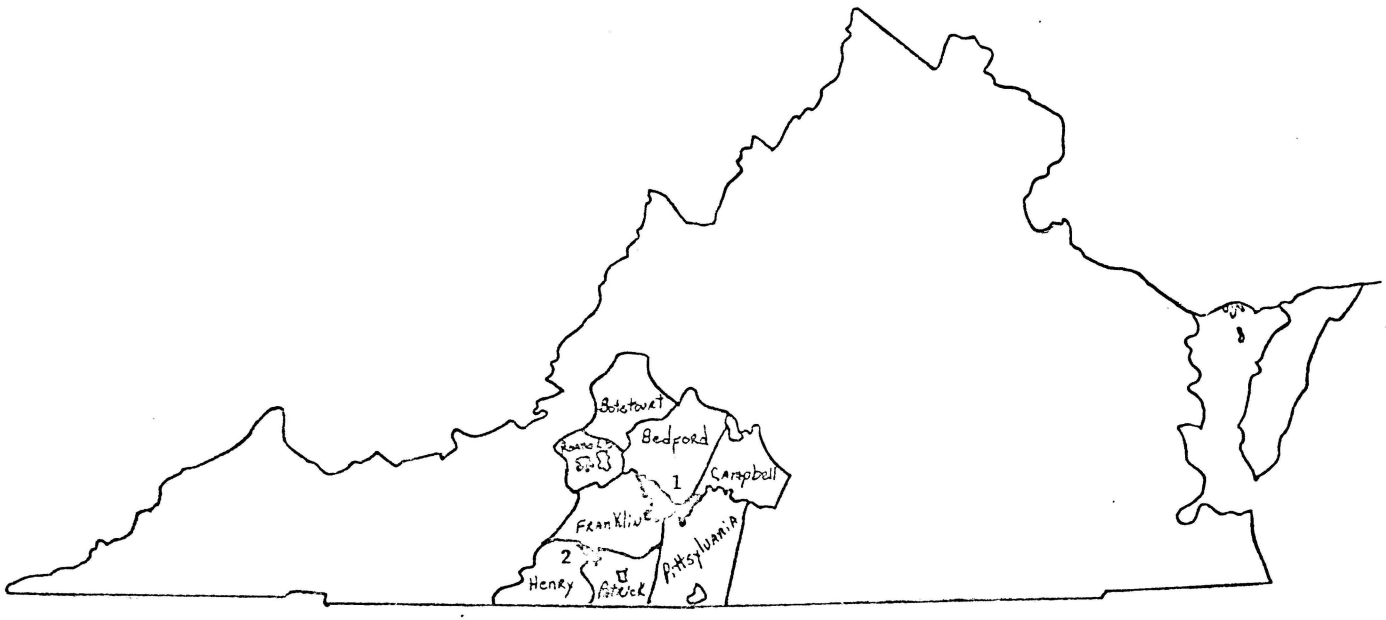


Figure 4. Map of Leesville-Smith Mountain Lake Study Area.

3. Summersville Lake

4. Sutton Lake

5. Bluestone Lake



Figure 5. Map of Summersville Lake Study Area.

6. East Lynn Lake



Figure 6. Map of East Lynn Lake Study Area.

where: r = rate of change,

n = number of years (10),

P_o = initial population (1960), and

P_n = new population (1970).

Using these growth rates, the number of households per year was calculated for each county. Then, by taking the number of boater registrations per county for each year of study and dividing it by the number of households per county for each of the same years of study, an annual boat registration per household figure was obtained for each county. To make these figures easier to work with (the numbers were very small) they were multiplied by 1000.[20]

The annual visitation figures were also collected for each of the alternative and study reservoirs for each year within their respective study periods. In the Leesville-Smith Mountain study area, the annual visitation figures for Philpott Lake for the years 1960-1963 were used before the study lakes were developed. For the Leesville-Smith Mountain Lake, it was necessary to interpolate the annual visitation values for the years other than 1967, 1969, 1971 and 1973 (the actual figures for these years are those found in the Federal Power Commission Reports as compiled by the Appalachian Power Company). The 1964-1966 figures were calculated on Leesville Lake alone. To obtain these values a growth relationship was established between the first four years since Leesville's inception and the first four years since Smith Mountain Lake's inception. Mean values are, then, used

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[20] Figures in Appendix A.

for the years 1968, 1970, and 1972. The total annual visitation figures were additive across each reservoir for each consecutive year.[21]

Combined annual visitation figures for Bluestone and Sutton Lakes provide the values before Summersville Lake was completed in 1966. In the East Lynn Study Area, combined annual visitation figures for Bluestone and Sutton Lakes for the years 1963-1965 and the annual visitation figures for Summersville for the years 1966-1971 were used before East Lynn Lake was completed.[22] The annual visitation figures for Summersville, East Lynn, Bluestone, Sutton, and Philpott Lakes are the actual values as compiled by their respective Corp Division Areas.[23]

These annual visitation figures aid in substantiating the assumption made earlier, that the quantity of boater registrations per 1000 households and annual user-days are well correlated. By estimating the relationship between the quantity of boater registrations per 1000 households and annual user-days or annual visitations, it can be determined whether the two are indeed highly correlated.

Using the Leesville-Smith Mountain Lake study area as a working example, each of the eight counties in the study area were tested and

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[21] Figures in Appendix A.

[22] Recall the closest alternative reservoir area(s) to the sample observations in each study area is used before the study reservoirs were completed, therefore, Bluestone and Sutton Lakes, then Summersville Lake when it was completed, are the alternative reservoirs for the East Lynn Lake study area.

[23] Figures in Appendix A.

observed independently of the others. The basic model subject to test is:

$$BR_H = f\ (AV) \tag{4.3}$$

where: AV is the number of annual visitations to the reservoir area, and

BR_H is the number of boater registrations per 1000 households by county.

Table 3 shows the annual visitation regression equations for each of the eight counties. In each of the equations, the correlation coefficients and the R^2 coefficients are relatively high, that is, boat registrations per 1000 households and annual visitations are highly linearly correlated with a high proportion of variation explained by the variable in the regression equation. Further the coefficients on the AV variable are positive and statistically significant at the .01% level. This means that BR_H and AV are directly related to one another, i.e., as the quantity of boater registrations increases per household so do annual visitations. Thus, within the range of the data the assumption that there is a high correlation between the quantity of boater registrations per 1000 households and annual user-days or annual visitations is not rejected.

The time/distance variable, as mentioned, is used as a proxy for price. It was important to select the components of this variable so as to obtain one price figure. First, a (national) average retail gas price ($/G) was computed for each year of study from an index for retail regular gas as compiled in the Consumer Index Report (1975). Next, a (national) average miles per gallon (M/G) figure was collected for passenger cars for each year of study from the "Federal Highway

Table 3. Annual Visitation Equations for Boater Registrations Per 1000 Households by County From 1960 to 1973 for the Leesville-Smith Mountain Lake Study Area.

BR_H	Constant	AV	R^2	R^2 (adj.)	Correlation	S-E
Bedford	-49.53	.00011934 (11.098)	.9112	.9038	.9546	11.7
Botetourt	- 7.414	.000022905 (10.015)	.8931	.8842	.9451	2.5
Campbell	4.483	.000022366 (6.034)	.7521	.7315	.8673	4.05
Franklin	-64.62	.00014901 (11.647)	.9187	.9120	.9585	14
Henry	15.29	.000020662 (7.628)	.8290	.8148	.9105	2.96
Patrick	- 1.047	.000016583 (6.934)	.8003	.7836	.8946	2.61
Pittsylvania	- 4.936	.000034898 (9.356)	.8794	.8694	.9378	4.07
Roanoke	3.88	.000027748 (8.090)	.8451	.8322	.9193	3.74

Statistics Division Administration Bulletin" (1975). Finally, distance figures, in miles (M), were calculated from the heart of the most populated area in each county (usually a major city) to an alternative reservoir before the reservoir under observation was completed and to the said study reservoir after it was completed. The time/distance variable for each county and year was, then, computed using these figures and the formula:[24]

$$(\$/G) * 1/(M/G) * (M) \text{ . } 100 \tag{4.4}$$[25]

This variable was used with the a priori hypothesis that as more and more costs are incurred as a result of greater distances to boating facilities and/or increased gas prices, the less likely people will purchase a boat(s). Further, as the price of recreational boating increases, the quantity of annual user-days decreases.[26] Thus, a negative coefficient for the time/distance variable is expected a priori.

The omission of actual speed (MPH) figures from the time/distance variable is readily explained. A 55 MPH speed limit was assumed for the traveled roads in all three study areas. This was done because the road conditions (e.g., terrain) faced by the recreationists to each of their respective reservoir areas are of a similar nature within each study area. Further, the speed limit changes for all

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[24]Figures in Appendix A.

[25]The variables were multiplied by 100 so they would be easier to work with.

[26]This relationship, in economic theory, is the law of demand which asserts that quantity demanded of a commodity varies inversely with the price of that commodity, ceteris paribus.

the roads under consideration and have been parallel over the years. Therefore, it is assumed that the time value involved is directly related to the distance traveled to the reservoir area by the recreationists.

Next the socio-economic variables were computed. The percentage of the population 25 and over who completed high school or better values were computed using a growth rate calculated from the 1960 and 1970 census figures for the 25 and over age subgroup of population who completed high school or better and formula (3.2). First, the 25 and over age of population subgroup was derived. Then, by dividing the education subgroup by the age subgroup for each county and year, the percentage figures of the population 25 and over who completed high school or better was obtained.[27]

The percentage of families earning $9000 or more ($9000 = 1974) entailed more detailed calculation. Since $9000 in 1974 is not equivalent to $9000 in 1960, present income figures had to be deflated. First the index figures for all goods was collected from the Consumer Price Index (1967 = 100). From these figures and setting $9000 to a base year, 1974, the equivalent of $9000 income levels were computed for each of the years 1960 - 1974.[28] Because the census only uses income brackets (e.g., $5000 - $5999), the exact number of families earning a particular income was difficult to determine. Thus, it was

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[27] Figures in Appendix A.

[28] Figures in Appendix A.

necessary to calculate using a growth rate, the number of families within each census income bracket for each consecutive year and for each county. Using the equivalent $9000 levels and the number of families in each census income bracket, the number of families earning the equivalent of $9000 or more in 1974 dollars were determined. These figures were, then, divided by the number of families (again derived by using the growth rate formula (3.2) for each year and county to obtain the percentages.[29]

The physical quality index variables were collected on Philpott, Leesville and Smith Mountain Lakes. The variables originally chosen to form the index included the number of shoreline miles available for recreational use, the reservoir size in water surface acres, the maximum pool fluctuation in feet, the length of the recreation season, the number of boat ramps and marinas, and the number of camping and picnic areas. The number of shoreline miles available for recreational use and the reservoir size in water surface acres did not change for each of the reservoirs over the years. The figures were additive across each reservoir for each year to show the change in the physical supply with the addition of the Leesville-Smith Mountain Lake project.[30] The maximum pool fluctuation in feet and the length of recreation season varied little between the reservoirs over the years but when valued across the figures were the same constant value for each year. The

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[29]Figures in Appendix A.

[30]Figures in Appendix A.

number of boat ramps and marinas and the number of camping and picnic areas at the Leesville-Smith Mountain Lake project were interpolated in the same manner (and for the same reason) as their annual visitation figures. That is, the 1964 - 1966 figures were calculated on Leesville alone by establishing a growth relationship between the first four years since Leesville's and Smith Mountain Lake's inception. Mean values were used for the years other than 1967, 1969, 1971, 1973 (values for these years are found in the Federal Power Commission Reports of the same years). The figures for Philpott Lake are the actual values as compiled by its Corp Division Area. The number of boat ramps and marinas and the number of camping and picnic areas were also additive for each year to show the change in the facilities provided by the addition of the Leesville-Smith Mountain Lake project.[31]

The basic index model subject to test is as follows:

$$I = b_1Y_1 + b_2Y_2 + \ldots + b_jY_j \qquad j = 1,\ldots 6 \qquad (4.5)$$

where Y_1 is the number of shoreline miles available for recreational use,

Y_2 = reservoir size (WSA),

Y_3 = maximum pool fluctuation (in feet),

Y_4 = length of the recreation season,

Y_5 = number of boat ramps and marinas,

Y_6 = number of camping and picnic areas, and

I = physical quality index.

Several principal component analyses were made in order to weight the variables for the best fit to form the index. The most satisfying in-

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[31] Figures in Appendix A.

dex was formed using the variables Y_1, Y_2, Y_5, Y_6. This resulted in a first eigen value of 3.83912 with 96% of the variation explained in the equation. The physical quality index equation is:

$$I = .25578Y_1 + .25577Y_2 + .25725Y_5 + .25190Y_6 \qquad (4.6)$$

Note each variable is equally weighted suggesting that each variable is equally significant in forming the index. Using the linear function 3.6, the factor score or index variable for each county and each year is, thus, determined.[32]

For the Summersville and East Lynn project where there was no variability in variables Y_1, Y_2, Y_5, Y_6, after the reservoir was constructed, a 0 dummy variable was used before the reservoir under observation was completed and a 1 dummy variable was used after the said reservoir was completed.

The lagged dependent variable used for all three study reservoirs is the number of registered boats per 1000 households lagged one year.

These variables were then utilized in the demand equation (3.1) for each of the three study areas. The findings of these estimations are presented in the next chapter.

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[32] Figures in Appendix A.

CHAPTER V

THE EMPIRICAL ANALYSIS AND RESULTS

As was stated in Chapter III, the demand for boating is considered a function of time/distance, certain socio-economic variables, a physical quality index, and a lagged dependent variable. The model subject to test is:

$$D_B = f\ (X_1, X_2 \ldots X_n \text{ or more specifically} \tag{5.1}$$

$$D_B = a + b_1X_1 + b_2X_2 + \ldots + b_iX_i + \ldots + D_{Bi}$$

$$i = 1, \ldots 5 \tag{5.2}$$

where: X_1 = the (average) total cost of a user-day of boating,

X_2 = the percentage of population 25 and over who completed high school or better,

X_3 = the percentage of families earning the equivalent of $9000 or more in 1974 dollars,

X_4 = physical quality index,

X_5 = lagged dependent variable, and

D_B = the number of registered boats per 1000 households.

It is the intent of this analysis to determine if the sample data reveals any significant relationships; more specifically, to determine if the physical quality index variable and the related lagged dependent variable reflecting the learning by doing process have a significant influence on boating demand. The hypothesis to be tested is whether

the learning by doing process as it relates to the physical availability of water has a significant influence on the demand for boating in ways not captured by the time/distance variable alone, i.e., the learning by doing process as it relates to the physical availability of water is a significant factor in the shifting of the demand for boating even after the time/distance influence has been accounted for. The above model is utilized in the estimation of boating demand in three different study areas: Leesville-Smith Mountain Lake, Summersville Lake, and East Lynn Lake.

Leesville-Smith Mountain Lake

The Leesville-Smith Mountain Lake study area is the first reservoir area to be studied. Located in Southwest Virginia, this study area encompasses the counties of Bedford, Botetourt, Campbell, Franklin, Henry, Patrick, Pittsylvania, and Roanoke and the Leesville and Smith Mountain Lakes. Philpott Lake is the closest alternative reservoir. The analysis is made for an initial fourteen year period, 1960-1973. The Leesville Lake portion of the project was completed in 1964 and the Smith Mountain Lake portion in 1967.

The first step in the analysis was a demand estimation regression omitting the physical quality index variable X_4 and the lagged dependent variable X_5. This original estimation serves as a "benchmark" for noting how the inclusion of these variables will effect the stability of the coefficients for the other variables. According to Table 4, the boating demand equation in simple linear form is:

Table 4. Boating Demand Equations for the Leesville-Smith Mountain Lake Study Area.

Equation	Years	Constant	X_1	X_2	X_3
5.3	60-73	23.22	-.43340 (-5.951)**	.17167 (.364)	.90345 (3.014)**
5.4	60-73	25.18	-.43763 (-6.111)**		.98257 (4.773)**
			$\ln X_1$		$\ln X_3$
5.5	60-73	.1973	-.91640 (-10.419)**		1.8014 (11.845)**
5.6	60-73	3.10	-.86314 (-11.529)**		1.0052 (5.718)**
5.7	61-73	1.969	-.45263 (-7.093)**		.73700 (5.718)**

Table 4. (Continued)

Equation	X_4	X_5	R^2 (adj.)	Std. Error	DF
5.3			.3360	14.1	108
5.4			.3413	13.0	109
5.5			.6802	.697	109
5.6	.35058 (6.648)**		.7710	.734	108
5.7	.13923 (3.357)**	.012688 (11.113)**	.8854	.562	99

$$D_B = 23.22 - .43340X_1 + .17167X_2 + .90345X_3 \qquad (5.3)$$

$$(-5.951)^{**} \quad (.364) \qquad (3.014)^{**}$$

$$R^2 \text{ (adj.)} = .3360$$

$$\text{Std. Error} = 14.1$$

The price and income variables, X_1 and X_3, behaved as expected a priori both being statistically significant and having their appropriate signs. Variable X_2 proved to be insignificant in this equation. Because of its insignificance, the education variable X_2 was omitted from further analysis of the boating demand equations.[33] Thus, equation 4.3 was reestimated (omitting variable X_2) with the following results:

$$D_B = 25.18 - .43763X_1 + .98257X_3 \qquad (5.4)$$

$$(-6.111)^{**} \quad (4.773)^{**}$$

$$R^2 \text{ (adj.)} = .3413$$

$$\text{Std. Error} = 13.0$$

Upon further observation of the equation, a change in the functional form of the equation was deemed desirable. A double logarithmetic (multiplication-linear) form was selected on the basis of certain criteria for choosing an appropriate functional form. Considered was (1) the adjusted R^2 (the higher the value of R^2 (adj.), the larger the proportion of the dependent variable is explained by the independent vari-

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**Statistically significant at the .01% level.

[33]Other specifications of the education variable X_2 are presented in Appendix B.

ables); (2) the expected signs or magnitudes (based on their theoretical justification) and statistical significance of the regression coefficients; (3) the residual (error term) patterns which reflect the appropriateness of the functional form and whether or not the specified regression has omitted any important variables; and (4) a comparison of graphs depicting the relationships of each independent with the dependent variable in, say, the simple linear and double log equation forms.

Equation 5.4 was reestimated in the double log form which yielded the following results:

$$\ln D_B = .1973 - .916401\ln X_1 + 1.80141\ln X_3 \qquad (5.5)$$

$$(10.419)^{**} \qquad (11.845)^{**}$$

$$R^2 \text{ (adj.)} = .6802$$

$$\text{Std. Error} = .697$$

Note the differences between equations 5.4 and 5.5. The adjusted R^2 has increased and the standard error reduced as a result of using the double log equation form. Variables $\ln X_1$ and $\ln X_3$ behaved similarly in both equations with both variables having a higher level of significance in equation 4.5 than in equation 4.4. The results of equation 5.5 suggest that the double log form was an appropriate functional equation form based on the criteria considered. Thus, the equations presented below are shown in this form.

**Statistically significant at the .01% level.

The next step in the analysis was to introduce the physical quality index variable X_4 into the boating demand equation (5.5).[34] The boating demand equation is as follows:

$$\ln D_B = 3.10 - .86314 \ln X_1 + 1.00521 \ln X_3 + .35058 X_4 \qquad (5.6)$$

$$(-11.529)^{**} \qquad (5.718)^{**} \qquad (6.648)^{**}$$

$$R^2 \text{ (adj.)} = .7710$$

$$\text{Std. Error} = .734$$

When variable X_4 was introduced into the boating demand equation, the adjusted R^2 was increased from .68 to .77. Variable X_4 did behave as expected having a positive sign and being statistically significant. The coefficients on the price and income variables were reduced but remained significant at the .01% level.

Next the lagged dependent variable X_5 was introduced into equation 5.6.[35] Since variable X_5 is lagged, the time period of analysis

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[34] The reader will note that variable X_4 is not logged. The reason for this is that some of the values for X_4 were negative and logs of negative numbers cannot be derived.

** Statistically significant at the .01% level.

[35] The reader will note that variable X_5 is also unlogged. The reason for this is because of the high correlation which exists between the logged dependent variable and variable X_5 if logged. Recall that variable X_5 is the dependent variable lagged one year. This high correlation results in the following equation where X_5 explains the majority of the variance of the dependent variable.

$$\ln D_B = 1.079 - .13959 \ln X_1 + .023561 \ln X_3 + .02836 X_4 +$$

$$.87313 \ln X_5 \qquad (-2.671)^{**} \qquad (.239) \qquad (.927)$$

$$(19.102)^{**}$$

$$R^2 \text{ (adj.)} = .9472$$

$$\text{Std. Error} = .399$$

is reduced by one year. Therefore, the following demand equation for boating is based on a thirteen year period from 1961 to 1973.

$$\ln D_B = 1.969 - .452631\ln X_1 + .737001\ln X_3 + .13923X_4 + .012688X_5 \quad (5.7)$$

$$(-7.093)^{**} \quad (5.718)^{**} \quad (3.357)^{**} \quad (11.113)^{**}$$

$$R^2 \text{ (adj.)} = .8854$$

$$\text{Std. Error} = .562$$

With the introduction of variable X_5, the adjusted R^2 is again increased from .77 to .89, and it has also resulted in a decrease of the price variable coefficient from -.86 to -.45 thereby causing the price elasticity of demand to become more inelastic. The income coefficient decreases, also, but remains positive and statistically significant. As evidenced by equations 5.6 and 5.7, the physical quality index variable X_4 and the lagged dependent variable X_5 have a significant positive influence on the demand for boating. Thus, the hypothesis that the learning by doing process as it relates to the physical availability of water has a significant influence on the demand for boating in ways not captured by the time/distance variable alone is not rejected.

The above results, also, imply that any consumer surplus (benefit) estimates would be underestimated if measured from a demand equation where variables X_4 and X_5 were omitted rather than from the fully specified demand equation. Figure 7 best illustrates the differences in consumers' surplus if estimated from the boating demand equations

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**Statistically significant at the .01% level.

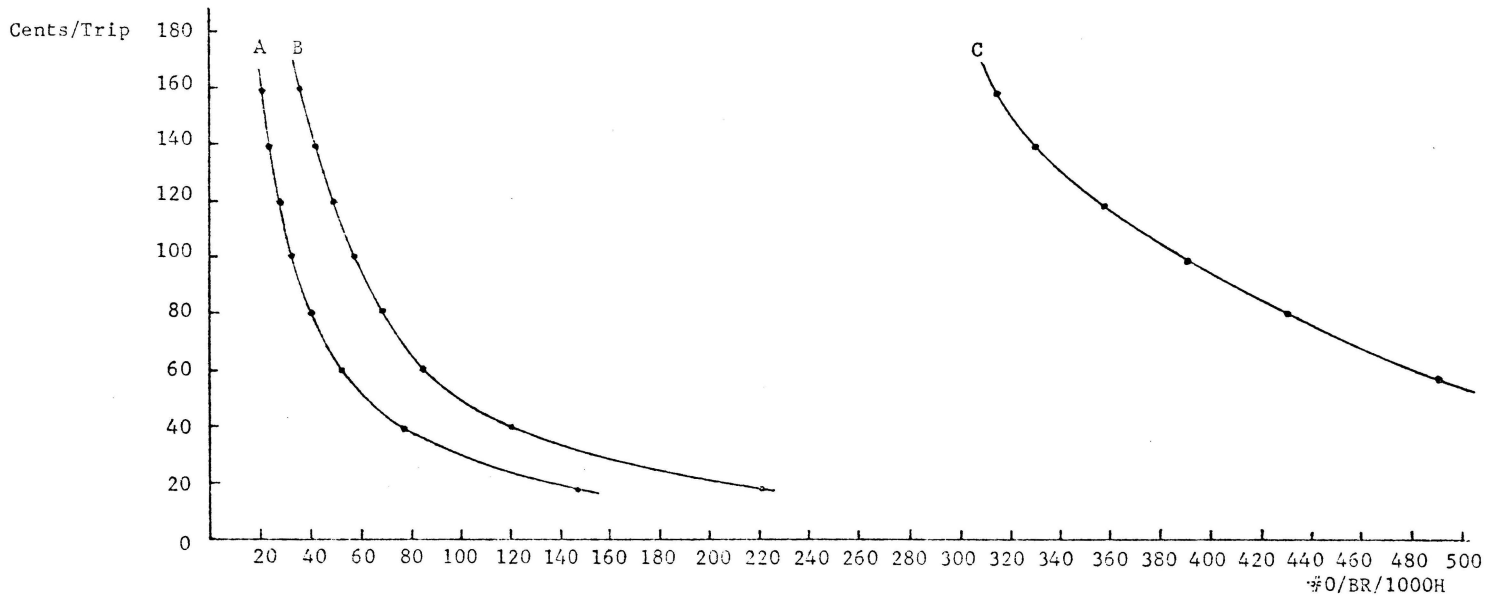


Figure 7. Estimated Demand Shifts Associated with the Addition of the Learning By Doing Variables in the Demand for Boating at the Leesville-Smith Mountain Lake Study Area.

5.5 (A), 5.6 (B) and 5.7 (C) where variables X_3, X_4 and X_5 were valued at the mean.

The development of the Leesville-Smith Mountain Lake project has resulted in a demand shift from A to B when variable X_4 was added to the boating demand equation and a further shift to C when both variables X_4 and X_5 were added. As indicated by Figure 7, equation 5.7 is the more appropriate equation for estimating consumer surplus benefits. If measured from the less sophisticated equations of 5.5 and 5.6, the benefits of the project would be grossly underestimated.

Failure to be cognizant of the learning by doing process as it relates to the physical availability of water could bias demand estimates and thus cause larger than actual benefits for new reservoir provisions to be estimated for regions with adequate facilities and smaller than actual benefits for regions where facilities are deficient.

Summersville Lake Study Area

The Summersville Lake Study Area is located in the eastern part of West Virginia and includes the counties of Braxton, Clay, Fayette, Greenbrier, Kanawha, Nicholas, Pocohontas, and Webster and the Summersville Lake itself. Bluestone and Sutton Lakes are considered the closest alternative reservoir areas for this study area. The initial time period of analysis is twelve years, from 1963 to 1974; the Summersville Lake project was completed in 1966.

Since these lakes, Summersville, Bluestone and Sutton, are governmentally owned and controlled projects built by the U.S. Army Corps

of Engineers, all investments in the physical quality of these reservoir areas were made at the onset of each project, thus, the physical capacities and the number of facilities provided by the reservoir areas did not change over the years except when the new Summersville Lake project was completed. As a result, a physical quality index variable if developed would react in a similar manner as that of a dummy variable. Therefore, a 0-1 dummy variable is used to represent the physical quality factor in the demand for boating in this study area. That is, variable X_4 will be represented by a variable taking the value of zero for all observations before 1966 and the value of one from 1966 to 1974 to reflect the addition of Summersville Lake in 1966. No conceptual problems exist when utilizing dummy variables and continuous variables in the same equation.

The first step in the analysis was again a demand estimation regression omitting the physical quality variable X_4 and the lagged dependent variable X_5 to provide a base for observing how the inclusion of these two variables will effect the stability of the coefficients for the other variables. According to Table 5, the boating demand equation in simple linear form is:

$$D_B = 19.35 - .22557X_1 + .32939X_2 + .52390X_3 \qquad (5.8)$$
$$(-10.226)^{**} \quad (1.254) \quad (2.870)^{**}$$
$$R^2 \text{ (adj.)} = .6883$$
$$\text{Std. Error} = 3.56$$

**Statistically significant at the .01% level.

Table 5. Boating Demand Equations for the Summersville Lake Study Area.

Equation	Years	Constant	X_1	X_2	X_3
5.8	63-74	19.35	-.22557 (-10.226)**	.32939 (1.254)	.52390 (2.870)**
5.9	63-74	18.68	-.20612 (-13.101)**		.72923 (9.008)**
			$\ln X_1$		$\ln X_3$
5.10	63-74	.4035	-.48501 (-6.486)**		1.2516 (4.214)**
			X_1		X_3
5.11	63-74	15.34	-.21200 (-14.321)**		.67998 (8.847)**
5.12	64-74	4.17	-.037066 (-2.621)**		.10547 (1.878)*

Table 5. (Continued)

Equation	X_4	X_5	R^2 (adj.)	Std. Error	DF
5.8			.6883	3.56	92
5.9			.6864	3.53	93
5.10			.3763	1.14	93
5.11	8.847 (3.771)**		.7254	3.42	92
5.12	-.10979 (-.078)	.87764 (15.312)**	.9260	2.18	83

The price and income variables, X_1 and X_3, behaved as expected *a priori*, i.e., having the appropriate signs and being statistically significant. Examination of the education variable X_2 shows it again to be insignificantly different from zero. The .20% level of significance on the education variable could be explained by the high correlation between income and education in the equation (See Appendix C, p.145). That is, variables X_2 and X_3 are so highly correlated that it is difficult to separate the effects of each (independently) on the dependent variable.[36] Variable X_2 was, therefore, omitted from further analysis of boating demand.[37] Equation 5.8 was reestimated having omitted variable X_2 and yielding the following results.

$$D_B = 18.68 - .20612X_1 + .72923X_3 \qquad (5.9)$$
$$(-13.101)^{**} \quad (9.008)^{**}$$
$$R^2 \text{ (adj.)} = .6864$$
$$\text{Std. Error} = 3.53$$

As expected in cases of multicollinearity when variable X_2 was omitted, the income coefficient significance increased.

When equation 5.9 was tested in a double log functional form, the following results were obtained:

$$\ln D_B = .4035 - .48501\ln X_1 + 1.25161\ln X_3 \qquad (5.10)$$
$$(-6.486)^{**} \quad (4.214)^{**}$$
$$R^2 \text{ (adj.)} = .3763$$
$$\text{Std. Error} = 1.14$$

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[36] This phenomena is frequently referred to as a multicolinearity effect.

[37] Other specifications of the education variable X_2 are presented in Appendix B.

** Statistically significant at the .01% level.

Comparing the equations 5.9 and 5.10, the price and income variables have reacted in a similar manner in both equations. However, the price coefficient has been reduced in equation 5.10 while in the same equation the income coefficient has increased. These magnitude changes has reduced the influence of variables X_1 and X_3 on boating demand though both remain statistically significant at the .01% level. Note, also, the adjusted R^2 has been reduced from .69 to .38 when the equation was estimated in double log form.

It is apparent from the above analysis that the simple linear form is the most appropriate form for this Summersville Lake Study Area boating demand equation because of the results of the estimates on the variables in the equation and the adjusted R^2's. The result of better fitting the demand model in the simple linear form for the Summersville Lake Study Area or in the double logged equation form for the Leesville-Smith Mountain Lake Study Area could be explained by the different characteristics of the regions themselves and/or the consumers reactions due to cultural differences which were assumed a priori to be reasonably similar in nature. The concern here is to obtain the best fitting equation for the demand model with respect to the a priori expected coefficient signs and significance and values of the adjusted R^2 and standard error. The next step in the analysis was to introduce the physical quality variable X_4 into the boating demand equation (5.9). The boating demand equation is as follows:

$$D_B = 15.34 - .21200X_1 + .67998X_3 + 8.847X_4 \qquad (5.11)$$

$$(-14.321)^{**} \quad (8.847)^{**} \quad (3.771)^{**}$$

$$R^2 \text{ (adj.)} = .7254$$

$$\text{Std. Error} = 3.42$$

When variable X_4 was introduced into the boating demand equation, the adjusted R^2 was increased from .69 to .72. As indicated by equation 5.11, the physical quality factor, as demonstrated by the dummy variable, has a significant positive influence on boating demand in the Summersville Lake Study Area also. The price variable X_1, however, is a more significant determinant than variable X_4.

Next the lagged dependent variable X_5 was introduced into equation 5.11. By utilizing this lagged variable, the time period of analysis was reduced by one year, thus, the data was observed over an eleven year period from 1964 to 1974. The result was the following boating demand estimation.

$$D_B = 4.17 - .037066X_1 + .10547X_3 - .10979X_4 + .87764X_5 \qquad (5.12)$$

$$(-2.621)^{**} \quad (1.878)^{*} \quad (-.078) \quad (15.313)^{**}$$

$$R^2 \text{ (adj.)} = .9260$$

$$\text{Std. Error} = 2.18$$

Examination of equation 5.12 in comparison to equation 5.11 reveals that equation 5.12 has a very high adjusted R^2 which is almost totally explained by the lagged dependent variable X_5. A highly significant

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*Statistically significant at the .05% level.

**Statistically significant at the .01% level.

determinant, variable X_5's influence is greater than the effect of the other variable in explaining total variance in the dependent variable. The coefficient on the price variable has increased from -.21 to -.04 causing its influence on boating demand in this equation to be reduced. The income coefficient has also been reduced to a .05% level of significance. Variable X_4 has proven to be insignificantly different from zero with the inclusion of variable X_5 into the boating demand equation.

Making generalizations as to the effects of learning by doing on the boating demand equations presented in this section could be misleading. There is considerable doubt that the above results represent the total learning by doing effect on the boating demand situation at Summersville Lake due to (1) the limited number of years of observation prior to the completion of the Summersville Lake project; and (2) the effect of the supply considerations, i.e., physical quality and learning by doing, on the demand for boating at Sutton Lake since it was only completed in 1960.

As mentioned earlier, when the lagged dependent variable was introduced into the boating demand equation, the number of study years prior to the completion of the Summersville Lake project was reduced from three to two years. The fact that the variables in equation 5.12 reflect limited observations prior to the Summersville Lake project completion date may have effected the boating demand estimations and, thus, the consumer surplus (benefit) estimations.

In addition, one of the alternative reservoir areas, Sutton Lake, had itself been recently developed prior to the completion of

the Summersville Lake project. The Sutton Lake project was developed in a region where the closest alternative reservoir area from it was 104 miles away. And, when completed in 1960, the demand for boating at Sutton Lake was subject to the same effects of changing physical supply and learning by doing as any newly developed reservoir. These effects may have had an influence on the number of boats being registered in the early (and/or median) years of the Summersville Lake study. Thus, the boating demand and consumer surplus (benefit) estimates for the Summersville Lake Study Area may have been effected for this reason. Consumer surplus estimates if taken from the above equations could be overestimates of the benefits derived from boating at Summersville Lake. They would reflect, in part, some of the increase in boating demand and participation caused by the effects of the Sutton Lake project.

East Lynn Lake Study Area

The East Lynn Lake Study Area in the western part of West Virginia encompasses the reservoir itself and the counties of Boone, Cabell, Kanawha, Lincoln, Logan, Mingo, Putnam, and Wayne. Bluestone and Sutton Lakes also provide the East Lynn Lake Study Area with reservoir area alternatives and when Summersville Lake was completed in 1966, it too became an alternative reservoir for this study area. The initial time period of study is twelve years, from 1963 to 1974; the East Lynn Lake project was completed in 1972.

In the East Lynn Lake Study Area the same problem exists concerning the physical quality variable as was presented in the pre-

vious section. That is, because East Lynn Lake is also a governmentally owned and controlled project built by the U.S. Army Corps of Engineers. All investments in the physical quality of the East Lynn Lake reservoir area, as well as the alternative reservoir areas, were made at the beginning of each project. Therefore, the physical capacities and the number of facilities provided by the reservoir areas did not vary over the years of study except when the East Lynn Lake project was completed. As a result, a physical quality index variable, if developed, would react similarly to a dummy variable in this study, also. Thus, a 0-1 dummy variable was again used to represent the physical quality factor in the demand equation for boating in this study area, i.e., variable X_4 is represented by a variable taking the value of zero for all observations before 1972 and the value of one from 1972 to 1974 to reflect the addition of East Lynn Lake in 1972.

The first step in the analysis was to estimate boating demand by omitting the physical quality variable X_4 and the lagged dependent variable X_5. This estimate would serve as a basis for observing how the coefficients of the other variables in the equation would react to the inclusion of variables X_4 and X_5. From Table 6, the simple linear equation form of the boating demand estimation is as follows:

$$D_B = 1974 - .061319X_1 + .41456X_2 + .064349X_3 \qquad (5.13)$$
$$\qquad\quad (-3.486)^{**} \quad (1.643) \qquad (.245)$$
$$R^2 \text{ (adj.)} = .2838$$
$$\text{Std. Error} = 9.91$$

**Statistically significant at the .01% level.

Table 6. Boating Demand Equations for the East Lynn Lake Study Area.

Equation	Years	Constant	X_1	X_2	X_3
5.13	63-74	19.74	-.061319 (-3.486)**	.41456 (1.643)	.064349 (.245)
5.14	63-74	12.83	-.056645 (-3.234)**		.44529 (3.568)**
			$\ln X_1$		$\ln X_3$
5.15	63-74	-2.667	-.023467 (-2.323)**		1.7503 (8.844)**
5.16	63-74	-3.713	-.012155 (-.012)		1.6861 (8.872)**
5.17	64-74	.3092	-.0079077 (-.099)		.43129 (2.537)**

Table 6. (Continued)

Equation	X_4	X_5	R^2 (adj.)	Std. Error	DF
5.13			.2838	9.91	92
5.14			.2707	9.06	93
5.15			.5320	1.09	93
5.16	.38408 (3.165)**		.5869	1.06	92
5.17	.055156 (.638)	.049448 (10.847)**	.8057	.815	83

Note that the price variable X_1 has the expected a priori sign and is statistically significant while the income variable X_3, though positive, is not significant. Examination of the education variable X_2 shows it to be positive and significant only at the .10% level. Here, too, the multicollinearity effect of the high correlation between income and education could account for this level of significance. (See Appendix C, p. .) It is because of this multicollinearity effect that the education variable X_2 was omitted from further analysis of boating demand in this section.[38] Education 5.13 was reestimated with variable X_2 omitted and the following results were obtained.

$$D_B = 12.83 - .056645X_1 + .44529X_3 \qquad (5.14)$$
$$(-3.234)^{**} \quad (3.568)^{**}$$
$$R^2 \text{ (adj.)} = .2707$$
$$\text{Std. Error} = 9.06$$

As expected with the exclusion of the education variable, the income coefficient increased to a .01% level of significance. Examination of the adjusted R^2 and the standard error suggests that a change in the function form of the equation is desired. Thus, equation 5.14 was reestimated in double log form with the following results.

$$\ln D_B = -2.667 - .0234671nX_1 + 1.75031nX_3 \qquad (5.15)$$
$$(-2.323)^{*} \quad (8.844)^{**}$$
$$R^2 \text{ (adj.)} = .5320$$
$$\text{Std. Error} = 1.09$$

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*Statistically significant at the .05% level.

**Statistically significant at the .01% level.

[38]Other specifications of the education variable X_3 are presented in Appendix B.

Note the differences in the two equations. In equation 5.15 the adjusted R^2 has increased from .27 to .53 and the standard error is reduced from 9.06 to 1.09 as a result of using the double log equation form. The coefficients on both the price variable X_1 resulting in a decrease in significance to a .05% level and the income variable X_5 which proves to be a highly significant determinant in this boating demand equation.

When the physical quality variable X_4 was introduced into equation 5.15, the following estimations were obtained.

$$\ln D_B = 3.713 - .0121551\ln X_1 + 1.68611\ln X_3 + .38408X_4 \qquad (5.16)$$

$$(-.012) \qquad (8.872)^{**} \quad (3.165)^{**}$$

$$R^2 \text{ (adj.)} = .5829$$

$$\text{Std. Error} = 1.06$$

The addition of variable X_4 in the boating demand equation has increased the adjusted R^2 from .53 to .58. The income variable remains positive and statistically significant. Variable X_4 has again proven to be a positive significant influence on the demand for boating. The influence of the price variable has, however, been reduced to a statistically insignificant level. This insignificance of the price variable can be readily explained.

It would seem <u>a priori</u> that the distance factor in the price variable would have shown variable $\ln X_1$ to be a highly significant determinant of boating demand for this area.

**Statistically significant at the .01% level.

The distances from the county observation points to East Lynn Lake are much shorter as compared to the distances from the county observation points to the alternative reservoirs. See Appendix A, p. 117.) However, the East Lynn Lake project was not completed until 1972, therefore, there was only a three year span of data on the East Lynn Lake Study Area to be observed. As a result, the price variable $\ln X_1$ has not had enough time to change and have a significant effect on boating demand in this study. Thus, the price influence to anyone of the three alternatives has the more dominant effect and this effect is insignificant due to the number of alternative reservoirs and their approximate distances to the county observation points. Therefore, it is probable that if a similar study were to be conducted for this area in later years, say, 1967 to 1980, the results would demonstrate a more significant boating demand relationship.

Continuing the present analysis, the lagged dependent variable X_5 was introduced into the boating demand equation 5.16. Again, by using this lagged variable the time period of study had to be reduced by one year making it a span of eleven years, from 1964 to 1974. This boating demand equation yielded the following estimations.

$$\ln D_B = .3092 - .00790771\ln X_1 + .431291\ln X_3 + .055156X_4$$
$$\qquad\qquad (-.099) \qquad\quad (2.537)^{**} \qquad (.638)$$
$$+ .049448X_5 \qquad\qquad (5.17)$$
$$(10.847)^{**}$$
$$R^2 \text{ (adj.)} = 8057$$
$$\text{Std. Error} = .815$$

**Statistically significant at the .01% level.

Comparing equations 5.16 and 5.17 reveals that equation 5.17 has a relatively higher adjusted R^2 which is explained almost totally by variable X_5. As indicated in equation 5.17, this variable outweighs the influence of the other variables in the equation as it did in the Summersville Lake study. The price variable remains insignificantly different from zero. The decreased coefficients on the income and physical quality variables has resulted in their decreased significance as determinants in the boating demand equation.

CHAPTER VI

Conclusions and Implications

Conclusions

The purpose of this study was to determine the significance of the effects of the learning by doing process as it relates to the availability of water on the demand for boating and to make inferences as to these effects on the consumer surplus concept of measuring recreational benefits. The study has established evidence that the learning by doing effects as captured by the physical qualities of the reservoirs and the lagged dependent variables are indeed significant positive influences on the demand for boating. This implies that when new recreational provisions are provided so as to make available and accessible water recreation opportunities a preceived large (relative) boating price decrease results. This price change not only results in a movement down a household's demand curve for boating (i.e., increase in quantity demanded) but it also results in a shift of the demand curve to the right (i.e., increase in demand) due to changes in consumers' tastes and preferences and production-technology (state of the arts) because of the learning by doing effect. The study, as indicated by Figure 7 in Chapter V, also suggests that any estimate of consumer surplus (benefits) measured from a demand equation where the learning by doing effects were ignored

would underestimate the more accurate consumer surplus (benefit) estimates from fully specified demand equations. Since consumer surplus values are generally an important consideration in resource allocation decisions, ignoring these effects could affect future provisions of recreational facilities.

Policy Implications

This study has shown empirically that there is some validity to the hypothesis that learning by doing as it relates to the physical availability of water is a significant determinant in estimating the demand for boating. The empirical analysis, however, is subject to several limitations as is discussed in the next section. Yet, the actual numbers are not what is important here. What is important is that recreation planners be cognizant of the effects of learning by doing on the demand for a recreational activity such as boating and their (effects) implications with regard to recreation provision decisions. Failure to consider these effects may result in underestimating the benefits associated with the provision of additional facilities in some areas. Such omissions may also result in underestimation of future use rates of the facility at any given price level. These biased estimations could misguide resource planners in their attempts to optimally allocate recreational resources.

The recreation planners should be aware that "needs" and "requirements" are a function of price and when price changes occur demand and quantity demanded are affected. They should be aware that the large relative price decrease due to the addition of a new recrea-

tion facility because of the learning by doing effects afford additional benefits for a given area where facilities are adequate (i.e., have reasonably close substitutes). And, that these effects will be even stronger (i.e., afford greater benefits) on activity demand estimations in areas with a paucity of such facilities. Failure to be cognizant of the learning by doing effects and their relationship to demand could lead to decisions to provide new provisions for regions already well endowed with facilities rather than providing provisions for regions with few or no facilities.

This study is important, therefore, in that, it opens the door to further investigation of the learning by doing process and its effects on future activity demand and value estimates. It encourages the recreation planner not to overlook this aspect of recreation demand when making resource allocation decisions. It suggests the future development of a basic methodology which will produce meaningful demand and value estimates which, in turn, will aid in determining the quantities, kinds and location of recreation provisions desired. By doing this, scarce natural resources can be more efficiently allocated by the public planning and budgetary allocation processes.

Research Implications

The implications of the findings reported in this study are important considerations with respect to future research needs.

After careful analysis of the data problems, further research into the specification of the variables used in this study is indicated. First, several implications as to the handling of the price

variable appear to be relevant. For example, there is the question of the omission of boat prices and operating and maintenance costs in the price variable. Information is needed as to the relationships between the price of boats and income over time and also the average cost of operating and maintaining a boat. This price-income/cost information could be important for several reasons. For example, if boat prices were decreasing and incomes remained constant or were increasing at the same time boat purchases and, thus, boat registrations would tend to increase, ceteris paribus. These increases would occur regardless of whether or not additional boating opportunities were provided. Therefore, any boating demand estimates could be biased from this standpoint, in that, an increase in the demand for boating and boating participation could be due in part to a decrease in boat prices. Likewise, if boat prices increased and incomes increased at the same time and rate, then boat prices would have little effect on the demand for boating and participation in the boating activity. This was the assumption of this study, however, a more comprehensive study would want to examine more closely the price-income relationship.

Consideration should also be given to the price of boating at substitute reservoir areas after the study reservoir area was developed. The price variable in this study only reflects the price of boating to the closest substitute reservoir area before and boating prices to the study reservoir area after it was developed. The exclusion of substitute reservoir area boating prices after the study reservoir was completed may have resulted in an overestimate of boating demand per unit price change at the new reservoir and participation

attributed to the addition of the new facility specifically for those counties in which the substitute reservoir areas were located or were closer to than the new reservoir area. It is conceivable that after an initial introduction period the novelty of the new reservoir area would wear off and the recreating unit would boat at the closest available opportunity to them.

Further research into the possible application of the above pricing aspects should be considered before a similar study is to be conducted.

Second, the addition of more factors reflecting substitute and compliment activities would seem necessary so as to reduce any bias on the physical quality index variable and to more accurately define the actual physical quality and ancillary facilities provided by a reservoir area. This requires further investigation into data sources and availability.

Third, when a lagged dependent variable is used, it generally produces the desired results. That is, the lagged dependent variable generally has the expected sign and magnitude with a corresponding high level of statistical significance. However, the effects of the lagged dependent variable in the regression model often results in biased regression estimates, the extent of which is not certain. These biased estimates are the result of a serial (time sequence) correlation of the error term and correlation between the lagged dependent variable and the error terms.[39] Utilization of more sophisti-

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[39]Serial correlation is an alternative term for auto correlation which describes a concept of interdependency among error terms.

cated econometric methods (e.g., Nerlovian lag model) to further investigate the learning by doing effects is perhaps warranted.

Finally, a household survey, if one were to be conducted, might be a more feasible alternative approach to describing the boating demand situation in a given geographical area. When using individual data, the effects of different levels of independent variables can be determined more precisely because (1) when not obscured by aggregated procedures, the interactions among the independent variables can be observed more directly and (2) the values of all the variables will fluctuate over a wider range for individual data than aggregated data. (Kalter and Gosse, 1969) In addition, the variables in the demand equation could be specified more accurately. Among the information which could be obtained from a survey would be better boating cost data including the cost of owning a boat(s) and the cost of participating in the boating activity (e.g., actual time values and distances traveled to participate in boating; better participation data, that is, questions as to where consumers actually boat in a given area with available substitutes and why they boat at a particular reservoir area; and, better socio-economic data. These are but a few considerations which would be explored if a survey was taken. All would be important factors in estimating actual boating demand. A survey was not conducted for this study due to the unavailability of data on registered boaters (i.e., names, addresses). Furthermore, the costs of conducting a survey of this nature would far outweight the returns associated with this study's modest objectives.

Other research implications suggest further investigation into the learning by doing effects on more and larger case study areas, on other recreational activities and on quantity demanded over longer periods of time.

More case studies could establish even further evidence that learning by doing is a significant determinant in boating demand. Also, more case studies for estimating the demand for other recreational activities would prove to be valuable when determining the value of compliment and substitute activities at a given recreation area.

Larger study areas would enable more substitute areas to be included. In the present study, Claytor Lake and Kerr Reservoir might have been significant influences on the number of registered boats in a given county. The learning by doing effects would be weaker for those areas where many reservoirs already exist. That is, the increase in participation resulting from the effects of the learning by doing process will be greatest on the first few reservoir facilities built in a region and less for additional reservoir development. Similarly, the present study omitted any consideration of out of state (or out of study area) participation in boating at the study reservoir area. Information on these other consumers may prove to be significant in reducing any bias on the demand estimates which might have occurred because of their lack of consideration.

The results of the study do not suggest the precise nature of the effects relating to the physical availability of water on boating participation (quantity demanded) over longer periods of time.

It is reasonable to believe that the learning by doing effect is not a linear function of time over many years. Rather the first few years after the development of a new reservoir facility in a region should witness the greatest increase in boating participation associated with the learning by doing effect. This effect, after several years, will in all likelihood decrease to a point and then level off where no further increases in quantity demanded would be taken. A hypothesized relationship is shown in Figure 8.

The determination of the rate of increase and decrease and the point of decrease and leveling off of boating participation is beyond the scope of this study. Further investigation into this aspect of the learning by doing effect appears to be warranted. Such information would enable decision makers to allocate future recreational provisions more efficiently.

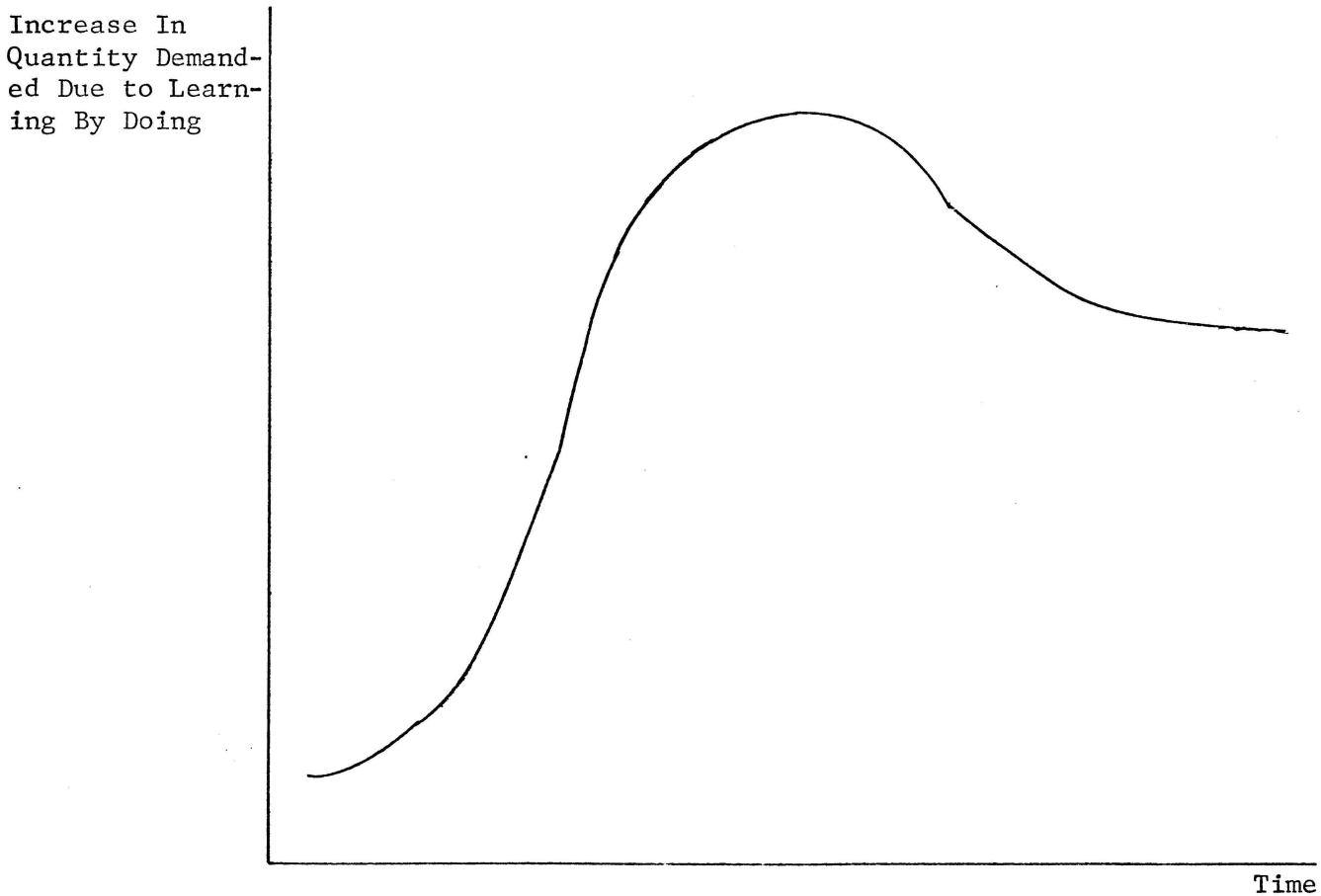


Figure 8. Hypothetical Relationship Between Time and Increases in Quantity Demanded Caused by Learning By Doing Effects.

REFERENCES

Appalachian Power Company. 1967. Licensed Projects Recreation Report No. 1. Washington, D.C.: Federal Power Commission.

Appalachian Power Company. 1969. Licensed Projects Recreation Report No. 2. Washington, D.C.: Federal Power Commission.

Appalachian Power Company. 1971. Licensed Projects Recreation Report No. 3. Washington, D.C.: Federal Power Commission.

Appalachian Power Company. 1973. Licensed Projects Recreation Report No. 4. Washington, D.C.: Federal Power Commission.

Batie, Sandra S. 1974. "Principle Component Analysis." Unpublished paper. Virginia Polytechnic Institute and State University.

Boyet, W. E. and G. S. Tolley. 1966. "Recreation Projection Based on Demand Analysis." Journal of Farm Economics, Vol. 48, No. 4, pp. 984-1001.

Brown, William B. and Farid Nawas. 1973. "Aggregation and Estimation of Recreation Demand." American Journal of Agricultural Economics, Vol. 55, No. 2, pp. 246-249.

Brown, William B., Ajmer Singh and Emery N. Castle. 1964. An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery. Technical Bulletin 78. Corvallis: Oregon State Agricultural Experiment Station.

Cicchetti, Charles J., Joseph J. Seneca and Paul Davidson. 1969. The Demand and Supply of Outdoor Recreation. New Brunswick: Bureau of Economic Research, Rutgers - The State University.

Clawson, Marion. 1959. Methods of Measuring the Demand for and Value of Outdoor Recreation. Reprint No. 10. Washington, D.C.: Resources for the Future.

Clawson, Marion and Jack L. Knetsch. 1966. Economics of Outdoor Recreation. Baltimore: The Johns Hopkins Press.

Craxton, Frederick E. and Dudley J. Cowden. 1955. Applied General Statistics. Second Edition. New York: Prentice Hall, Inc.

Daiute, R. J. 1966. "Methods for Determination of Demand for Outdoor Recreation." Land Economics, Vol. 42, No. 3, pp. 327-338.

Davidson, Paul F., Gerard Adams, and Joseph Seneca. 1966. "The Social Value of Recreational Facilities Resulting from an Improvement in Water Quality: The Delaware Estuary."

Dixon, W. J. and F. J. Massey. 1969. Introduction to Statistical Analysis, Third Edition. New York: McGraw-Hill Book Company.

Gilmour, Campbell M. 1973. A Statistical Estimate of the Demand for and Value of Outdoor Recreation in the Sawtooth Valley and Mountain Area, Idaho. Moscow: Water Resources Research Institute.

Gum, Russell L. and William E. Martin. 1973. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation." Unpublished Paper. University of Arizona.

Hines, L. G. 1958. "Measurement of Recreation Benefits: A Reply." Land Economics, Vol. 34, No. 4, pp. 365-367.

Hogarty, Thomas F. and Robert J. Mackay. 1975. "Some Implications of the 'New Theory of Consumer Behavior' for Interpreting Estimated Demand Elasticities." American Journal of Agricultural Economics, Vol. , No. , pp. 340-343.

Hu, Teh-wei. 1973. Econometrics An Introductory Analysis. Baltimore: University Park Press.

Jennings, Thomas A. and Kenneth C. Gibbs. 1974. "Some Issues Concerning Specification and Interpretation of Outdoor Recreation Demand Models." Southern Journal of Agricultural Economics, Vol. 6, No. 1, pp. 165-169.

Kalter, Robert J. 1969. "Communications User Response in Outdoor Recreation: A Comment." Journal of Leisure Research, Vol , pp. 131-134.

Kalter, Robert J. 1971. "The Economics of Water-Based Outdoor Recreation: A Survey and Critique of Recent Developments." IWR Report 71-8.

Kalter, Robert J. 1971. Recreational Demand Functions: Concepts, Problems and Uses. Staff Paper 44. Ithaca: New York State College of Agriculture, Cornell University.

Kalter, Robert J. and Lois E. Gosse. 1969. Outdoor Recreation: Projections For 1970-1985. Ithaca: New York State College of Agriculture, Cornell University.

Kalter, Robert J. and Lois E. Gosse. 1970. "Recreation Demand Functions and the Identification Problem." Journal of Leisure Research, Vol. , No. , pp. 43-53.

Knetsch, Jack L. 1963. "Outdoor Recreation Demands and Benefits." Land Economics, Vol. 39, No. 4, pp. 387-396.

Knetsch, Jack L. 1964. "Economics of Including Recreation as a Purpose of Eastern Water Projects." Journal of Farm Economics, Vol. 46, No. 5, pp. 1148-1157.

Knetsch, Jack L. and Robert K. Davis. 1966. "Comparison of Methods for Recreation Evaluation," in Dorfman, R. and N. S. Dorfman (eds.). Economics of the Environment. New York: W. W. Norton and Company, Inc., pp. 384-402.

McConnell, Kenneth E. 1975. "Some Problems in Estimating the Demand for Outdoor Recreation." American Journal of Agricultural Economics, Vol. , No. , pp. 330-334.

McCoy, E. W. 1966. "Analysis of the Utilization of Outdoor Recreation in Tennessee." Unpublished Ph.D. Dissertation, University of Tennessee.

National Park Service, U.S. Department of the Interior. 195. A Method of Evaluating Recreation Benefits of Water Control Projects. Washington, D.C.: Government Printing Office.

Outdoor Recreation Resources Review Commission. 1962. "Prospective Demand for Outdoor Recreation." ORRRC Study Report 26. Washington, D.C.: Government Printing Office.

Pearse, Peter H. 1968. "A New Approach to the Evaluation of Non-Priced Recreational Resources." Land Economics, Vol. 44, No. 1, pp. 87-99

Seneca, J. J. and C. J. Cicchetti. 1969. "User Response in Outdoor Recreation: A Production Analysis." Journal of Leisure Research, Vol. 1, No. 3, pp. 238-245.

Spencer, Milton H. 1971. Contemporary Economics. New York: World Publishers, Inc.

Stevens, J. B. 1966. "Recreation Benefits of Water Pollution Control." Water Resources Research, Vol. 2, No. 2, pp. 167-182.

Stevens, J. B. 1968. "Measurement of Economic Values in Sport Fishing: An Economist's Views on Validity, Usefulness, and Propriety." Technical Paper . Corvallis: Oregon State Agricultural Experiment Station.

Stoevener, H. H. and W. G. Brown. 1967. "Analytical Issues in Demand Analysis for Outdoor Recreation." Journal of Farm Economics, Vol. 49, No. 5, pp. 1295-1306.

Trice, A. H. and S. E. Wood. 1958. "Measurement of Recreation Benefits." Land Economics, Vol. 34, No. 3, pp. 195-207.

Tussey, Robert C. 1967. Analysis of Reservoir Recreation Benefits. Research Report No. 2. Lexington: University of Kentucky Water Resources Institute.

U.S. Bureau of Census. 1960. Census of Population: Virginia, West Virginia. Washington, D.C.: Government Printing Office.

U.S. Bureau of Census. 1970. Census of Population: Virginia, West Virginia. Washington, D.C.: Government Printing Office.

Wennergren, E. B. 1964. "Valuing Non-Market Priced Recreational Resources." Land Economics, Vol. 60, pp. 303-314.

APPENDIX A

DATA DESCRIPTION

Table A-1a. The Number of Registered Boats by County for the Leesville-Smith Mountain Lake Study Area.

Year	Bedford County	Botetourt County	Campbell County	Franklin County	Henry County	Patrick County	Pittsylvania County	Roanoke County
1960	36	19	235	97	338	22	241	545
1961	74	22	351	149	457	36	329	760
1962	86	30	413	172	524	41	393	942
1963	103	28	283	170	435	39	383	875
1964	186	36	548	219	495	47	503	1109
1965	358	45	697	360	574	57	702	1408
1966	625	67	781	248	593	55	912	1638
1967	798	86	933	643	687	62	1067	1967
1968	1018	112	1084	847	796	78	1268	2350
1969	1056	102	1016	884	771	77	1210	2349
1970	1119	124	1037	1012	831	94	1313	2468
1971	1161	121	1062	1088	913	100	1404	2538
1972	1366	163	1193	1439	1078	129	1642	2808
1973	1671	232	1383	1791	1341	176	1989	3308

Source: The Boat Section, Virginia Commission of Game and Inland Fisheries.

Table A-1b. The Number of Registered Boats Per 1000 Households for the Leesville-Smith Mountain Lake Study Area.

Year	Bedford County	Botetourt County	Campbell County	Franklin County	Henry County	Patrick County	Pittsylvania County	Roanoke County
1960	4.341	4.158	9.445	14.538	21.784	5.408	8.465	11.653
1961	8.773	4.726	13.835	22.026	28.605	8.718	11.42	15.895
1962	10.025	6.326	15.964	25.078	31.854	9.782	13.481	19.262
1963	11.805	5.796	10.728	24.448	25.682	9.167	12.983	17.497
1964	20.959	7.314	20.372	31.063	28.382	10.884	16.85	21.687
1965	39.663	8.974	25.411	50.364	31.964	13.004	23.241	26.926
1966	68.08	13.115	27.924	34.22	32.07	12.362	29.838	30.633
1967	85.465	16.525	32.714	87.509	36.084	13.728	34.498	35.974
1968	107.195	21.124	37.275	113.695	40.604	17.015	40.515	42.03
1969	109.329	19.068	34.262	117.037	58.196	16.548	38.207	41.085
1970	113.9	22.533	34.295	132.15	39.983	19.903	40.971	42.213
1971	116.195	21.583	34.443	140.129	42.662	20.859	43.295	42.452
1972	134.415	28.539	37.945	182.799	48.921	26.51	50.039	45.932
1973	161.665	39.871	43.988	224.4	59.104	35.632	59.9	52.916

Table A-1c. The Number of Registered Boats by County for the Summersville Lake Study Area.

Year	Braxton County	Clay County	Fayette County	Greenbrier County	Kanawha County	Nicholas County	Pocohontas County	Webster County
1963	143	32	326	89	1683	123	5	71
1964	148	32	341	92	1793	180	5	80
1965	153	32	357	95	1910	257	6	91
1966	159	32	374	99	2034	366	6	103
1967	148	28	350	91	1786	365	5	96
1968	111	30	320	70	1526	345	3	78
1969	168	41	454	110	2167	452	7	104
1970	146	48	708	132	2215	460	4	94
1971	151	42	492	142	2277	453	4	80
1972	142	47	493	125	2163	441	5	71
1973	148	55	527	132	2494	431	4	63
1974	170	58	603	120	2469	458	6	66

Source: West Virginia Division of Water Resources.

Table A-1d. The Number of Registered Boats Per 1000 Households for the Summersville Lake Study Area.

Year	Braxton County	Clay County	Fayette County	Greenbrier County	Kanawha County	Nicholas County	Pocohontas County	Webster County
1963	34.899	11.478	20.253	9.11	22.98	18.557	1.752	21.295
1964	36.233	11.566	21.351	9.352	24.422	27.099	1.755	24.358
1965	37.574	11.656	22.527	9.589	25.951	38.608	2.109	28.127
1966	37.169	11.745	23.784	9.922	27.568	54.866	2.111	32.318
1967	36.573	10.356	22.432	9.057	24.147	54.599	1.762	30.578
1968	27.516	11.182	20.67	6.918	20.581	51.498	1.059	25.221
1969	41.775	15.4	29.555	10.795	29.155	67.326	2.474	34.138
1970	36.418	18.168	46.058	12.863	29.727	68.371	1.415	31.323
1971	37.783	16.02	32.532	13.74	30.484	67.187	1.417	27.062
1972	35.642	18.065	32.853	12.011	28.887	65.268	1.774	24.381
1973	37.264	21.303	35.393	12.594	33.225	63.652	1.421	21.962
1974	42.937	22.638	40.814	11.369	32.811	67.495	2.135	23.356

Table A-1e. The Number of Registered Boats by County for the East Lynn Lake Study Area.

Year	Boone County	Cabell County	Kanawha County	Lincoln County	Logan County	Mingo County	Putnam County	Wayne County
1963	98	757	1683	18	156	71	111	166
1964	75	809	1793	22	175	80	126	199
1965	57	866	1910	27	197	89	143	237
1966	44	927	2034	33	222	100	162	281
1967	147	816	1786	35	216	97	141	250
1968	138	691	1526	20	167	122	122	185
1969	197	1014	2167	42	263	135	178	300
1970	232	1003	2215	47	289	128	191	323
1971	262	1065	2277	46	343	148	194	350
1972	281	1048	2163	49	386	171	221	340
1973	323	1145	2494	110	513	197	223	492
1974	342	1267	2469	124	635	240	271	1579

Source: West Virginia Division of Water Resources.

Table A-1f. The Number of Registered Boats Per 1000 Households for the East Lynn Lake Study Area.

Year	Boone County	Cabell County	Kanawha County	Lincoln County	Logan County	Mingo County	Putnam County	Wayne County
1963	13.284	22.416	22.98	3.508	10.665	7.445	16.085	15.396
1964	10.128	23.77	24.422	4.249	12.103	8.421	17.765	18.295
1965	7.668	25.247	25.951	5.167	13.784	9.404	19.615	21.598
1966	5.897	26.816	27.568	6.258	15.715	10.607	21.62	25.383
1967	19.625	23.422	24.147	6.576	15.468	10.329	18.308	22.385
1968	18.354	19.68	20.581	3.724	12.099	8.658	15.412	16.42
1969	26.102	28.655	29.155	7.488	19.277	14.485	21.877	26.393
1970	30.623	28.124	29.727	8.592	21.43	13.787	22.839	28.168
1971	34.452	29.631	30.484	8.333	25.731	16.003	22.569	30.255
1972	36.81	28.932	28.887	8.796	29.294	18.561	25.014	29.133
1973	42.152	31.364	33.225	19.566	39.387	21.465	24.557	41.788
1974	44.463	34.437	32.811	21.855	49.324	26.251	29.034	132.937

Table A-2a. Annual Visitation Figures for the Leesville-Smith Mountain Lake Study Area

Year	Philpott	Leesville	Smith Mountain	Total
1960	707,385			707,385
1961	686,430			686,430
1962	644,500			644,500
1963	542,800			542,800
1964	450,000	10,791		460,791
1965	503,600	38,913		542,513
1966	766,500	67,035		833,535
1967	904,800	68,800	62,700	1,036,300
1968	891,500	70,650	226,100	1,188,250
1969	866,200	72,500	389,500	1,328,200
1970	881,800	81,250	399,750	1,362,800
1971	938,400	90,000	410,000	1,438,400
1972	1,072,800	92,500	420,500	1,585,800
1973	1,237,700	95,000	431,000	1,763,700

Source: For Philpott, the Wilmington Division, U.S. Army Corps of Engineers; For Leesville and Smith Mountain, the Federal Power Commission. Reports submitted by the Appalachian Power Company.

Table A-2b. Annual Visitation Figures for the Summersville Lake Study Area.

Year	Bluestone	Sutton	Summersville	Total
1963	392,527	454,700		847,227
1964	539,175	847,300		1,386,475
1965	625,558	1,158,500		1,784,058
1966	611,519	552,500	1,239,300	2,403,319
1967	614,628	596,900	870,700	2,082,228
1968	609,767	588,000	847,800	2,045,567
1969	771,053	621,800	908,900	2,301,753
1970	879,598	484,589	1,202,200	2,566,387
1971	1,020,736	539,283	1,516,100	3,076,119
1972	1,039,766	624,234	1,392,520	3,056,518
1973	1,085,857	650,870	1,427,870	3,164,597
1974	1,080,073	599,323	1,333,620	3,013,016

Source: The Kanawha Division, U.S. Army Corps of Engineers.

Table A-2c. Annual Visitation Figures for the East Lynn Lake Study Area.

Year	Bluestone	Sutton	Summersville	East Lynn	Total
1963	392,527	454,700			847,227
1964	539,175	847,300			1,386,475
1965	625,558	1,158,500			1,784,058
1966	611,519	552,500	1,239,300		2,403,319
1967	614,628	596,900	870,700		2,082,228
1968	609,767	588,000	847,800		2,045,567
1969	771,053	621,800	908,900		2,301,753
1970	879,598	484,589	1,202,200		2,566,387
1971	1,020,736	539,283	1,516,100		3,076,119
1972	1,039,766	624,232	1,392,520	515,150	3,571,668
1973	1,085,857	650,870	1,427,870	581,000	3,145,597
1974	1,080,073	599,323	1,333,620	582,000	3,595,016

Source: The Big Sandy Division, U.S. Army Corps of Engineers.

Table A-3a. Distances Traveled to the Leesville-Smith Mountain Lake Study Area.

Year	Bedford (Bedford City)	Botetourt (Buchanan)	Campbell (Lynchburg City)	Franklin (Rocky Mount)
	---------- miles ----------			
1960[a]	63	71	87	25
1961	63	71	87	25
1962	63	71	87	25
1963	63	71	87	25
1964[b]	19	41	42	13
1965	19	41	42	13
1966	19	41	42	13
1967[c]	19	41	35	13
1968	19	41	35	13
1969	19	41	35	13
1970	19	41	35	13
1971	19	41	35	13
1972	19	41	35	13
1973	19	41	35	13

[a]To Philpott Lake.

[b]To Leesville Lake only.

[c]To the closest Leesville or Smith Mountain Lake.

Table A-3a. (Continued)

Year	Henry (Martinsville City)	Patrick (Stuart)	Pittsylvania (Danville City)	Roanoke (Roanoke City)
	---------- miles ----------			
1960[a]	18	20	47	47
1961	18	20	47	47
1962	18	20	47	47
1963	18	20	47	47
1964[b]	32	58	40	30
1965	32	58	40	30
1966	32	58	40	30
1967[c]	32	58	40	15
1968	32	58	40	15
1969	32	58	40	15
1970	32	58	40	15
1971	32	58	40	15
1972	32	58	40	15
1973	32	58	40	15

[a]To Philpott Lake.

[b]To Leesville Lake only.

[c]To the closest Leesville or Smith Mountain Lake.

Table A-3b. Distances Traveled to the Summersville Lake Study Area.

Year	Braxton (Sutton)	Clay (Clay)	Fayette (Fayetteville)	Greenbrier (White Sulphur Springs)
	----------	----------	miles ----------	----------
1963[a]	2	45	50	42
1964	2	45	50	42
1965	2	45	50	42
1966[b]	34	42	31	63
1967	34	42	31	63
1968	34	42	31	63
1969	34	42	31	63
1970	34	42	31	63
1971	34	42	31	63
1972	34	42	31	63
1973	34	42	20	63
1974	34	42	20	63

[a]To Sutton or Bluestone Lakes.

[b]To Summersville Lake.

Table A-3b. (Continued)

Year	Kanawha (Charleston)	Nicholas (Summersville)	Pocohontas (Marlinton)	Webster (Webster Springs)
	---------- miles ----------			
1963[a]	86	34	83	19
1964	86	34	83	19
1965	86	34	83	19
1966[b]	69	2	66	40
1967	69	2	66	40
1968	69	2	66	40
1969	69	2	66	40
1970	69	2	66	40
1971	69	2	66	40
1972	69	2	66	40
1973	69	2	66	40
1974	69	2	66	40

[a]To Sutton or Bluestone Lakes.

[b]To Summersville Lake.

Table A-3c. Distances Traveled to the East Lynn Lake Study Area.

Year	Boone (Madison)	Cabell (Huntington)	Kanawha (Charleston)	Lincoln (Hamlin)	Logan (Logan)	Mingo (Williamson)	Putnam (Winfield)	Wayne (Wayne)
	miles							
1963[a]	99	136	86	122	111	154	113	154
1964	99	136	86	122	111	154	113	154
1965	99	136	86	122	111	154	113	154
1966[b]	80	119	69	105	111	154	96	137
1967	80	119	69	105	111	154	96	137
1968	80	119	69	105	111	154	96	137
1969	80	119	69	105	111	154	96	137
1970	80	119	69	105	111	154	96	137
1971	80	119	69	105	111	154	96	137
1972[c]	46	31	67	31	45	75	69	13
1973	46	31	67	31	45	75	69	13
1974	46	31	67	31	45	75	69	13

[a]To Sutton or Bluestone Lakes.

[b]To Bluestone or Summersville Lakes.

[c]To East Lynn Lakes.

Table A-4. Average Miles Per Gallon for a Passenger Car

Year	Average MPG
1960	14.28
1961	14.38
1962	14.37
1963	14.26
1964	14.25
1965	14.07
1966	14.00
1967	13.93
1968	13.79
1969	13.63
1970	13.57
1971	13.57
1972	13.49
1973	13.10
1974	13.51

Source: Federal Highway Statistics Division Administration Bulletin (1975).

Table A-5. Retail Regular Gas Prices (1967 = 100).

Year	Index	Gas Price
1960	93.7	$.331
1961	90.3	.299
1962	94.0	.312
1963	91.7	.304
1964	91.7	.304
1965	95.3	.316
1966	98.6	.327
1967	99.8	.331
1968	101.4	.336
1969	104.7	.347
1970	107.4	.356
1971	107.3	.356
1972	110.2	.366
1973	131.9	.438
1974	159.1	.528

Source: Consumer Index Report, 1975.

Table A-6a. The Percentage of the Population Who Completed High School or Better for the Leesville-Smith Mountain Lake Study Area.

Year	Bedford County	Botetourt County	Campbell County	Franklin County	Henry County	Patrick County	Pittsylvania County	Roanoke County
1960	25.54	28.11	34.87	19.26	24.51	17.76	28.93	28.73
1961	26.25	28.99	35.68	20.01	25.41	18.36	29.65	30.5
1962	28.03	29.9	36.51	20.79	26.34	18.99	30.39	32.38
1963	30.02	30.84	37.36	21.61	27.3	19.65	31.14	31.38
1964	32.11	31.82	38.23	22.45	28.3	20.33	31.92	36.49
1965	34.34	32.83	39.12	23.33	29.34	21.04	32.72	38.74
1966	36.73	33.86	40.03	24.22	30.42	21.78	33.54	41.13
1967	39.29	34.93	40.96	25.19	31.55	22.55	34.38	43.67
1968	42.02	36.04	41.91	26.18	32.71	23.35	35.24	46.36
1969	44.95	37.19	42.89	27.2	33.92	24.18	36.13	49.22
1970	48.08	38.36	43.88	28.27	35.18	25.05	37.04	52.26
1971	51.42	39.59	44.9	29.38	36.48	25.96	37.98	55.48
1972	55.01	40.85	45.95	30.53	37.84	26.9	38.94	58.9
1973	58.84	42.16	47.02	31.73	39.25	27.88	39.92	62.54

Table A-6b. The Percentage of the Population Who Completed High School or Better for the Summersville Lake Study Area.

Year	Braxton County	Clay County	Fayette County	Greenbrier County	Kanawha County	Nicholas County	Pocohontas County	Webster County
1963	21.14	17.52	23.48	31.65	43.24	23.83	26.55	17.01
1964	21.83	17.73	24.22	32.44	44.46	24.81	27.28	17.72
1965	22.54	17.94	24.99	33.26	45.73	25.84	28.03	18.47
1966	23.28	18.17	25.79	34.1	47.04	26.91	28.8	19.26
1967	24.06	18.4	26.62	34.97	48.38	28.02	29.6	20.08
1968	24.86	18.64	27.48	35.86	49.77	29.19	30.42	20.94
1969	25.69	18.88	28.36	36.77	51.2	30.41	31.26	21.85
1970	26.55	19.14	29.28	37.72	52.68	31.68	32.13	22.81
1971	27.45	19.4	30.23	38.69	54.2	33.01	33.04	23.81
1972	28.38	19.67	31.22	39.68	55.77	34.41	33.96	24.86
1973	29.35	19.96	32.24	40.71	57.39	35.86	34.92	25.96
1974	30.36	20.24	33.3	41.77	59.06	37.38	35.91	27.12

Table A-6c. The Percentage of the Population Who Completed High School or Better for the East Lynn Lake Study Area.

Year	Boone County	Cabell County	Kanawha County	Lincoln County	Logan County	Mingo County	Putnam County	Wayne County
1963	19.47	41.52	43.24	16.91	22.07	21.03	29.05	28.37
1964	20.05	42.57	44.46	17.82	22.78	21.47	30.57	29.39
1965	20.65	43.64	45.73	18.79	23.68	21.92	32.18	30.44
1966	21.68	44.73	47.04	19.81	24.61	22.39	33.87	31.53
1967	21.92	45.86	48.38	20.89	25.59	22.86	35.66	32.66
1968	22.59	47.01	49.77	22.03	26.61	23.35	37.53	33.84
1969	23.28	48.19	51.2	23.24	27.68	23.85	39.52	35.06
1970	24.0	49.4	52.68	24.52	28.8	24.38	41.61	36.35
1971	24.75	50.65	54.2	25.88	29.96	24.9	43.81	37.65
1972	25.53	51.92	55.77	27.31	31.19	25.44	46.14	39.02
1973	26.33	53.22	57.39	28.83	32.46	26.0	48.59	40.44
1974	27.16	54.56	59.06	30.44	33.8	26.57	51.17	41.92

Table A-7. Income Levels Equivalent to $9000 or More ($9000 = 1974).

Year	Consumer Price Index (1967 = 100)	Income Levels Equivalent to $9000 in 1974 Dollars
1960	88.7	$5404.87
1961	89.6	5459.71
1962	90.6	5520.65
1963	91.7	5587.68
1964	92.9	5560.8
1965	94.5	5758.29
1966	97.2	5922.82
1967	100	6093.42
1968	104.2	6349.36
1969	109.8	6690.59
1970	116.3	7086.66
1971	121.3	7391.33
1972	125.3	7635.07
1973	133.1	8110.36
1974	147.7	9000

Source: Consumer Price Index, 1975.

Table A-8a. The Percentage of Families Earning the Equivalent of $9000 or More in 1974 Dollars for the Leesville-Smith Mountain Lake Study Area.

Year	Bedford County	Botetourt County	Campbell County	Franklin County	Henry County	Patrick County	Pittsylvania County	Roanoke County
1960	34.2	32.94	51.71	31.99	47.87	19.	34.08	52.86
1961	35.47	34.48	52.52	33.98	49.6	21.03	35.89	53.76
1962	37.04	36.36	53.64	36.23	51.59	23.41	37.97	54.99
1963	38.81	38.63	55.11	38.78	53.86	26.22	40.34	56.56
1964	41.19	41.38	56.95	41.68	56.45	29.56	43.06	58.52
1965	43.89	46.73	59.2	44.99	59.41	33.54	46.17	60.91
1966	47.09	48.75	61.9	48.77	62.77	38.3	49.73	63.76
1967	43.5	45.31	56.71	43.72	57.61	33.07	45.02	59.03
1968	48.3	51.44	60.97	48.66	62.23	41.73	49.85	63.98
1969	53.45	58.8	65.81	54.31	67.41	49.83	55.37	68.53
1970	53.53	59.19	64.55	52.72	63.47	50.13	53.33	67.1
1971	61.15	69.85	71.07	60.09	70	61.31	60.44	73.87
1972	70.02	82.7	78.41	68.57	77.36	75.1	68.62	81.5
1973	72.35	89.82	79.4	65.45	77.22	80.8	69.01	82.32

Table A-8b. The Percentage of Families Earning the Equivalent of $9000 or More in 1974 Dollars ($9000 = 1974) for the Summersville Lake Study Area.

Year	Braxton County	Clay County	Fayette County	Greenbrier County	Kanawha County	Nicholas County	Pocohontas County	Webster County
1963	27.86	26.41	41.43	35.1	61.6	35.99	27.58	23.92
1964	29.75	27.71	43.07	37.71	62.61	38.24	30.01	25.64
1965	31.84	29.26	44.91	40.6	63.94	40.88	32.68	27.62
1966	34.17	31.08	46.97	43.82	65.9	44.01	35.64	29.91
1967	29.67	25.31	40.75	37.17	60.38	38.8	29.3	25.35
1968	32.56	28.06	43.63	41.02	63.27	43.45	32.4	28.56
1969	35.77	31.23	46.79	45.31	66.52	48.81	38.15	32.22
1970	32.83	27.51	42.61	42.15	63.47	46.97	31.35	50.91
1971	36.57	31.64	46.52	47.0	67.95	54.0	35.08	35.48
1972	40.76	36.46	50.81	49.15	72.86	62.17	39.29	40.73
1973	37.56	28.95	46.17	45.26	70.64	61.95	35.65	39.11
1974	33.04	28.77	38.92	37.74	68.27	58.62	33.89	33.47

Table A-8c. The Percentage of Families Earning the Equivalent of $9000 or More in 1974 Dollars ($9000 = 1974) for the East Lynn Study Area.

Year	Boone County	Cabell County	Kanawha County	Lincoln County	Logan County	Mingo County	Putnam County	Wayne County
1963	42.66	56.81	61.6	28.07	49.21	37.66	50.67	43.44
1964	43.7	58.37	62.61	30.01	50.01	38.81	52.61	45.36
1965	45.09	60.19	63.94	32.26	51.16	40.18	55.01	47.61
1966	46.85	62.3	65.6	34.88	52.7	41.79	57.92	50.21
1967	39.63	56.66	60.38	30.49	46.38	34.64	53.79	45.09
1968	42.82	59.89	63.27	34.2	49.41	37.1	58.38	48.93
1969	46.46	63.43	66.52	38.5	52.86	39.86	63.68	53.29
1970	44.64	58.82	63.47	34.66	50.61	36.66	61.55	50.28
1971	49.66	63.24	67.95	40.1	55.41	40.32	68.85	55.97
1972	55.29	68.06	72.86	46.47	60.75	44.39	77.18	62.42
1973	49.95	65.25	70.64	46.1	58.42	40.84	76.71	60.34
1974	43.62	62.91	68.27	44.21	51.45	36.1	71.23	57.83

Table A-9. The Number of Shoreline Miles Available for Recreational Use at Leesville-Smith Mountain Lake Study Area.

Year	Philpott	Leesville	Smith Mountain	Total
1960	100			100
1961	100			100
1962	100			100
1963	100			100
1964	100	64.6		164.6
1965	100	64.6		164.6
1966	100	64.6		164.6
1967	100	64.6	408	572.6
1968	100	64.6	408	572.6
1969	100	64.6	408	572.6
1970	100	64.6	408	572.6
1971	100	64.6	408	572.6
1972	100	64.6	408	572.6
1973	100	64.6	408	572.6

Source: See page 7.

Table A-10. The Reservoir Size in Water Surface Areas for the Leesville-Smith Mountain Lake Study Area.

Year	Philpott	Leesville	Smith Mountain	Total
1960	2880			2880
1961	2880			2880
1962	2880			2880
1963	2880			2880
1964	2880	3400		6280
1965	2880	3400		6280
1966	2880	3400		6280
1967	2880	3400	20700	26980
1968	2880	3400	20700	26980
1969	2880	3400	20700	26980
1970	2880	3400	20700	26980
1971	2880	3400	20700	26980
1972	2880	3400	20700	26980
1973	2880	3400	20700	26980

Table A-11. The Number of Boat Ramps and Marinas at the Leesville-Smith Mountain Lake Study Area.

Year	Philpott	Leesville	Smith Mountain	Total
1960	10			10
1961	11			11
1962	12			12
1963	14			14
1964	14	2		16
1965	15	3		18
1966	18	4		22
1967	18	4	31	53
1968	19	5	48	72
1969	19	6	64	89
1970	19	7	72	98
1971	19	8	79	106
1972	19	6	79	104
1973	19	4	78	101

Source: See page 7.

Table A-12. The Number of Camping and Picnic Areas at the Leesville-Smith Mountain Lake Study Area.

Year	Philpott	Leesville	Smith Mountain	Total
1960	6			6
1961	8			8
1962	12			12
1963	14			14
1964	15	1		16
1965	15	1		16
1966	37	2		39
1967	37	2	12	51
1968	37	2	27	66
1969	37	2	41	80
1970	43	1	55	99
1971	42	0	68	110
1972	42	3	68	113
1973	47	5	69	121

Source: See page 7.

Table A-13. Physical Quality Index Variables for the Leesville-Smith Mountain Lake Study Area.

Year	Physical Quality Index
1960	-1.126218
1961	-1.107817
1962	-1.077513
1963	-1.052613
1964	-0.878099
1965	-0.865104
1966	-0.702225
1967	0.498265
1968	0.710998
1969	0.904785
1970	1.076345
1971	1.193796
1972	1.198655
1973	1.226774

Table A-14. The Change in the Number of Boat Registrations Per Household (Per 1000) From Time Period t-2 to t-1 (Alternate Lagged Variable) for the Leesville-Smith Mountain Lake Study Area.

Year	Bedford County	Botetourt County	Campbell County	Franklin County	Henry County	Patrick County	Pittsylvania County	Roanoke County
1962	4.432	.568	4.39	7.488	6.821	3.31	2.955	4.242
1963	1.252	1.6	2.129	3.052	3.249	1.064	2.061	3.367
1964	1.78	-.53	-5.236	-.63	-6.172	-.615	-.498	-1.765
1965	9.154	1.518	9.644	6.615	2.7	1.717	3.867	4.19
1966	18.704	1.66	5.039	19.30	3.582	2.12	6.391	5.239
1967	28.417	4.141	2.513	-16.144	.106	-.642	6.597	3.707
1968	17.385	3.41	4.79	53.289	4.014	1.366	4.66	5.341
1969	21.73	4.599	4.561	26.186	4.52	3.287	6.017	6.056
1970	2.134	-2.056	-3.013	3.342	-2.408	-.467	-2.308	-.945
1971	4.511	3.465	.033	15.112	1.787	3.355	2.764	1.128
1972	2.295	-.95	.148	7.979	2.679	.956	2.324	.239
1973	18.22	6.956	3.502	42.67	6.259	5.651	6.744	3.48

APPENDIX B

ALTERNATIVE BOATING EQUATIONS

Education Variable

In Chapters III and V, boating demand was originally stated as being a function of time/distance, certain socio-economic variables, a physical quality index, and a lagged dependent variable. The original boating demand model was:

$$D_B = a + b_1X_1 + b_2X_2 + \ldots + b_iX_i + \ldots + D_{Bi} \quad i = 1,\ldots 5 \qquad (B1.0)$$

where: X_1 = the (average) total cost of a user-day of boating,

X_2 = the percentage of population 25 and over who completed high school or better,

X_3 = the percentage of families earning the equivalent of $9000 or more in 1974 dollars,

X_4 = physical quality index,

X_5 = lagged dependent variable, and

D_B = the number of registered boats per 1000 households.

Upon the examination of the results of the original boating demand analyses for each of the study areas the education variable X_2 was disgarded from further analysis in the boating demand equation either because of its insignificance in the boating demand equation under observation or because of its multicollinearity effects with regard to the income variable. In Chapter V the boating demand equations with variable X_2 omitted were presented. Here the boating demand equations with variable X_2 included are presented to show the effects of the inclusion of this education variable on the boating demand equations.

Table B-1. Boating Demand Equations for the Leesville-Smith Mountain Lake Study Area When Variable X_2 Was Included.

Equations	Years	Constant	X_1	X_2	X_3	X_4
B1.1	60-73	74.07	-.4023 (-6.123)**	-.019013 (-.045)	.020890 (.065)	20.218 (5.197)**
			$\ln X_1$	$\ln X_2$	$\ln X_3$	
B1.2	60-73	.1763	-.91625 (-10.369)**	.026184 (.104)	1.7832 (7.677)**	
B1.3	60-73	3.181	-.86337 (-11.487)	-.08580 (-.401)	1.0609 (4.723)**	.35225 (6.633)**
B1.4	61-73	2.092	-.45395 (-7.11)	-.14163 (-.969)	.83230 (5.133)**	.14046 (3.384)**
B1.5	62-73	3.447	-.73709 (-9.262)	-.0050246 (-.025)	.76470 (3.218)**	.33046 (6.261)**
B1.6	61-73	3.742	-.87246 (-10.633)**	-.0092058 (-.040)	.88271 (3.320)**	
B1.7	61-73	1.503	-.43283 (-6.436)**	-.11896 (-.779)	.93439 (5.279)**	

Table B-1. (Continued)

Equations	X_5	$X_5^{\hat{}}$	X_4^{t-1}	R^2(adj)	Std. Error	DF
B1.1				.4649	16.0	108
B1.2				.6773	.728	108
B1.3				.7692	.764	107
B1.4	.012727 (11.137)**			.8854	.577	98
B1.5		.022941 (5.012)**		.7770	.847	90
B1.6			.32616 (5.362)**	.7174	.906	99
B1.7	.013623 (11.202)**		.069545 (1.495)	.8748	.635	98

Table B-2. Boating Demand Equations for the Summersville Lake Study Area When Variable X_2 Was Included.

Equations	Years	Constant	X_1	X_2	X_3
B2.1	63-74	15.95	-.22744 (-10.991)**	.26354 (1.067)	.51670 (3.018)**
			$\ln X_1$	$\ln X_2$	$\ln X_3$
B2.2	63-74	-.3068	-.33284 (-4.557)**	-2.4254 (-5.050)**	3.4819 (6.766)**
B2.3	63-74	-.1526	-.33764 (-4.65)**	-2.4971 (-5.209)**	3.4576 (6.761)**
			X_1	X_2	X_3
B2.4	64-74	4.44	-.041804 (-2.382)	.065123 (.460)	.066694 (.658)

Table B-2. (Continued)

Equations	X_4	X_5	R^2(adj)	Std. Error	DF
B2.1	7.8712 (3.687)**		.7258	3.47	91
B2.2			.5064	1.04	92
B2.3	.26318 (1.502)		.5131	1.02	91
B2.4	-.12778 (-.091)	.87383 (15.019)**	.9253	2.27	82

Table B-3. Boating Demand Equations for the East Lynn Lake Study Area When Variable X_2 Was Included.

Equations	Years	Constant	X_1	X_2	X_3
B3.1	63-74	10.99	-.031548 (-1.534)	.354157 (1.386)	.095963 (.376)
			$\ln X_1$	$\ln X_2$	$\ln X_3$
B3.2	63-74	-1.743	-.25231 (-2.515)**	.48984 (1.795)*	1.1070 (2.712)**
B3.3	63-74	-2.92	-.039646 (-.330)	.38698 (1.464)	1.1818 (3.009)**
B3.4	64-74	.08030	.001912 (.024)	-.14853 (-.774)	.60243 (2.158)*

Table B-3. (Continued)

Equations	X_4	X_5	R^2(adj)	Std. Error	DF
B3.1	9.5876 (2.595)**		.3258	10.2	91
B3.2			.5430	1.19	92
B3.3	.36068 (2.964)**		.5786	1.21	91
B3.4	.056596 (.653)	.050405 (10.648)**	.8048	.869	82

Alternatate Lagged Dependent Variable

In an attempt to quantify the learning by doing effect, an alternate lagged dependent variable was tested. This variable, X_5', is defined as the change in the number of registered boats per 1000 households from the year t-2 to the year t-7.[39] By using this variable, the time period of analysis was reduced by two years to a twelve year period from 1962 to 1973. The variable X_5' was added to equation 5.6 (Chapter V) with the following results:

$$\ln D_B = 3.442 - .736851\ln X_1 + .761201\ln X_3 + .33040X_4 + .022949X_5' \quad \text{(B4.1)}$$
$$(-9.377)^{**} \quad (4.010)^{**} \quad (6.301)^{**} \quad (5.052)^{**}$$

$$R^2 \text{ (adj.)} = .7794$$

$$\text{Std. Error} = .820$$

Comparing equations 5.7 and B4.1, the price and physical quality index coefficients in equation 4.7 have increased while maintaining their appropriate signs and statistical significance. The income and lagged dependent coefficients are reduced in equation B4.1 though they too maintain their appropriate signs and statistical significance. Note, too, that the adjusted R^2 is lowered in equation B4.1. These results indicated that in equation B4.1, variables X_1 and X_2 have more of an influence on boating demand than variable X_5'.

These results along with the additional reduction in the number of study years suggest that the original lagged dependent variable

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**Statistically significant at the .01% level.

[39]See figures in Appendix A.

used in equation 5.7 is a more satisfactory measure of the learning by doing effect.

Lagged Physical Quality Index Variable

A further analysis of boating demand was made by substituting a lagged physical index variable for the original unlagged index variable in the boating demand equation. Lagging the physical quality index variable X_4 by one year reflects Seneca's hypothesis (according to Cicchetti, et al., 1969) that changes in the supply in the previous year (t-1) explained participation in the present year (t) better than supply changes in the present year and thus a higher correlation between demand and supply lagged one year is indicated.[40] For the purpose of comparisons, the boating demand equation was estimated (for the years 1961-1973) first with variable X_5 omitted. The results are as follows:

$$\ln D_B = 3.735 - .872281\ln X_1 + .876201\ln X_3 + .32616X_4^{t-1} \qquad (B5.1)$$

$$(-10.70)^{**} \quad (4.177)^{**} \quad (5.389)^{**}$$

$$R^2 \text{ (adj.)} = .7202$$

$$\text{Std. Error} = .884$$

As expected, all the variables behaved as anticipated a priori, i.e., all being statistically significant and having their appropriate

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**Statistically significant at the .01% level.

[40] See discussion on page 20, Chapter II.

signs. Note that the price variable $\ln X_1$ is highly significant with reference to the demand for boating in this equation. The reactions of the variables in equation B5.1 are comparable to those in equation 5.6 (Chapter V) with a lower adjusted R^2 occuring in equation (B5.1).

Adding the lagged dependent variable X_5 to equation B5.1 yielded these results:

$$\ln D_B = 1.42 - .432491\ln X_1 + .850361\ln X_3 + .070735X_4^{t-1}$$
$$(-6.444)^{**} \quad (6.072)^{**} \quad (1.525)$$
$$+ .013562X_5 \qquad (B5.2)$$
$$(11.198)^{**}$$

$$R^2 \text{ (adj.)} = .8753$$

$$\text{Std. Error} = 1.42$$

In equation B5.2, the price ($\ln X_1$) and lagged physical quality index (X_4^{t-1}) coefficients have been reduced with the introduction of variable X_5. Variable X_4^{t-1} has been reduced to a .10% level of significance while $\ln X_1$, though reduced, is still significant at the .07% level. The income variable, $\ln X_3$, remains positive and statistically significant. The lagged dependent variable X_5, as evidenced by equation 4.9, has again been shown to be a more significant influence on the demand for boating.

The only major difference between equation 5.7 (Chapter V) and equation B5.2 is in the physical quality index variables. As mentioned above, the lagged physical quality index variable in equation B5.2 has a lower coefficient at a lesser level of significance (.10%) while the unlagged variable in equation 5.7 has a higher coefficient

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**Statistically significant at the .01% level.

and is statistically significant at the .01% level. As suggested by this analysis, there exists a higher correlation between physical supply in the present year and the demand for boating in the present year. In either case, the learning by doing (lagged dependent) variable is a highly influential determinant in the boating demand equation, thus, reconfirming the non-rejection of the tested hypothesis.

The results, again, imply that any consumer surplus estimates measured from a demand equation where the learning by doing proxy variable was omitted would be an underestimation of benefits if measured from the fully specified demand equation regardless of how the physical quality factor is specified.

APPENDIX C

CORRELATION COEFFICIENTS MATRICES

Table C-1a. Simple Correlation Matrix for the Leesville-Smith Mountain Lake Study Area for the Years 1960-1973.

Variables	D_B	X_1	X_2	X_3	X_4	LnD_B	LnX_1	LnX_2	LnX_3	X_4
D_B	1.0000									
X_1	-.4669	1.0000								
X_2	.3324	-.1032	1.0000							
X_3	.3628	.0104	.7193	1.0000						
X_4	.5465	-.0681	.5577	.7056	1.0000					
LnD_B						1.0000				
LnX_1						-.5309	1.0000			
LnX_2						.4699	.0236	1.0000		
LnX_3						.6110	.0455	.7533	1.0000	
X_4						.6788	-.0478	.5442	.6776	1.0000

Table C-1b. Simple Correlation Matrix for the Leesville-Smith Mountain Lake Study Area for the Years 1961-1973.

Variables	D_B	X_1	X_2	X_3	X_4	X_5	X_4^{t-1}
D_B	1.0000						
X_1	-.4788	1.0000					
X_2	.3022	-.1321	1.0000				
X_3	.3266	.0182	.7000	1.000			
X_4	.5188	-.0419	-	.6916	1.0000		
X_5	.9788	-.4696	.3389	.3545	.5463	1.0000	
X_4^{t-1}	.5158	-.0178	.5335	.7387	-	.5552	1.0000

Table C-1b. (Continued)

Variables	LnD_B	LnX_1	LnX_2	LnX_3	X_4	X_5	X_4^{t-1}
LnD_B	1.0000						
LnX_1	-.5504	1.0000					
LnX_2	.4337	-.0046	1.0000				
LnX_3	.5639	.0440	.7344	1.0000			
X_4	.6489	-.0276	.5222	.6722	1.0000		
X_5	.8745	-.4936	.3226	.3741	.5463	1.0000	
X_4^{t-1}	.6214	-.0120	.5192	.7058	-	.5552	1.0000

Table C-1c. Simple Correlation Matrix for the Leesville-Smith Mountain Lake Study Area for the Years 1962-1973.

Variables	D_B	X_1	X_2	X_3	X_4	X_5
D_B	1.0000					
X_1	-.4928	1.0000				
X_2	.2736	-.1725	1.0000			
X_3	.2876	.0235	.6778	1.0000		
X_4	.4904	-.0148	.4977	.6715	1.0000	
X_5	.5801	-.3029	.0004	.0075	.1320	1.0000

Table C-1c. (Continued)

Variables	LnD_B	LnX_1	LnX_2	LnX_3	X_4	X_5
LnD_B	1.0000					
LnX_1	-.5669	1.0000				
LnX_2	.4080	-.0465	1.0000			
LnX_3	.5177	.0380	.7121	1.0000		
X_4	.6178	-.0082	.4906	.6602	1.0000	
X_5	.4916	-.3467	.0077	.0305	.1320	1.0000

Table C-2a. Simple Correlation Matrix for the Summersville Lake Study Area for the Years 1963-1974.

Variables	D_B	X_1	X_2	X_3	X_4	LnD_B	LnX_1	LnX_2	LnX_3	X_4
D_B	1.0000									
X_1	-.6520	1.0000								
X_2	.0555	.5502	1.0000							
X_3	.3554	.2279	.8547	1.0000						
X_4	.1899	.1454	.2320	.1968	1.0000					
LnD_B						1.0000				
LnX_1						-.5224	1.0000			
LnX_2						-.0189	.2338	1.0000		
LnX_3						.3366	.0092	.8365	1.0000	
X_4						.0959	.0925	.2544	.2220	1.0000

Table C-2b. Simple Correlation Matrix for the Summersville Lake Study Area for the Years 1964-1974.

Variables	D_B	X_1	X_2	X_3	X_4	X_5
D_B	1.0000					
X_1	-.6800	1.0000				
X_2	.0404	.5373	1.0000			
X_3	.3512	.1903	.8506	1.0000		
X_4	.1414	.1238	.1908	.1456	1.0000	
X_5	.9605	-.6604	.0545	.3588	.1777	1.0000

Table C-2b. (Continued)

Variables	LnD_B	LnX_1	LnX_2	LnX_3	X_4	X_5
LnD_B	1.0000					
LnX_1	-.5286	1.0000				
LnX_2	-.0257	.2092	1.0000			
LnX_3	.3351	-.0430	.8310	1.0000		
X_4	.0670	.0796	.2099	.1609	1.0000	
X_5	.8373	-.7360	.0683	.3618	.1777	1.0000

Table C-3a. Simple Correlation Matrix for the East Lynn Lake Study Area for the Years 1963-1974.

Variables	D_B	X_1	X_2	X_3	X_4	LnD_B	LnX_1	LnX_2	LnX_3	X_4
D_B	1.0000									
X_1	-.4339	1.0000								
X_2	.4465	-.2673	1.0000							
X_3	.4536	-.3785	.8882	1.0000						
X_4	.4744	-.6012	.2782	.3107	1.0000					
LnD_B						1.0000				
LnX_1						-.3957	1.0000			
LnX_2						.6856	-.2557	1.0000		
LnX_3						.7178	-.3374	.8851	1.0000	
X_4						.4643	-.6286	.2783	.2903	1.0000

Table C-3b. Simple Correlation Matrix for the East Lynn Lake Study Area for the Years 1964-1974.

Variables	D_B	X_1	X_2	X_3	X_4	X_5
D_B	1.0000					
X_1	-.4330	1.0000				
X_2	.4190	-.2639	1.0000			
X_3	.4277	-.3726	.8862	1.0000		
X_4	.4622	-.6090	.2654	.3026	1.0000	
X_5	.7653	-.4049	.6482	.6503	.4875	1.0000

Table C-3b. (Continued)

Variables	LnD_B	LnX_1	LnX_2	LnX_3	LnX_4	X_5
LnD_B	1.0000					
LnX_1	-.3963	1.0000				
LnX_2	.6575	-.2504	1.0000			
LnX_3	.6884	-.3316	.8841	1.0000		
X_4	.4629	-.6297	.2666	.2841	1.0000	
X_5	.8938	-.4069	.6785	.6711	.4875	1.0000

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RECREATIONAL FACILITY PROVISION EFFECTS ON THE ESTIMATION OF DERIVED DEMANDS FOR BOATING

by

Linda Gaye Hogue

(ABSTRACT)

Outdoor recreation continues to increase as a major use of the nation's natural resources. Rational resource allocation decisions require knowledge of meaningful demand and value estimates for outdoor recreation. A study was conducted to determine the effects of the learning by doing process as it relates to the physical availability of water on the demand for boating in three case study reservoir areas.

The learning by doing concept is based on the idea that if facilities are available, individual consumers in time period t would learn or develop a demand for a recreational activity (e.g., boating) which would result in an increase in their demand for boating in time period t_2. Moreover, through social interaction, the boating demand of their families and friends increases in t_2 also. The effect of new water recreational provisions is a large (relative) decrease in boating price. This price change results in a movement down the consumers' demand curve for boating, but it also results in a shift of the demand curve to the right due to changes in consumers' tastes and preferences and production-consumption technology because of the learn-

ing by doing effect. Thus, benefits as measured by consumers' surplus, can be derived from learning by doing.

An ordinary least squares regression analysis of combined time-series and cross-section data approach was employed to obtain the statistical demand estimates. The estimations derived establish evidence that these recreational facility provision effects are significant positive influences on the demand for boating. Failure to be cognizant of these effects could lead to resource allocation decisions being made which would result in imbalances of recreational facilities provided.