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AN ESTIMATION OF USER BENEFITS ASSOCIATED
WITH THE MICHIGAN PUBLIC ACCESS SITE
PROGRAM FOR INLAND LAKES

By

Thomas Donald Warner

A DISSERTATION

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ABSTRACT

AN ESTIMATION OF USER BENEFITS ASSOCIATED WITH THE MICHIGAN PUBLIC ACCESS SITE PROGRAM FOR INLAND LAKES

By

Thomas Donald Warner

The 1930's saw the first state effort in Michigan to provide public access sites to the state's vast water resources. Since the initiation of the state public access site program, many changes have come about in the design of the sites and their administration. Since 1968, when the Michigan State Waterways Commission became the primary public access site administrator, an on-going research process has evaluated the criteria used for site selection.

Conscious of both the economics of public expenditures and the need for a scientific basis for future acquisitions, the Waterways Commission sought a study that would estimate dollar benefits attributable to the use of the public access sites. By estimating dollar benefits, existing sites can be measured for cost effectiveness and proposed sites would have a basis for selection and development: sites with the highest estimated dollar benefits receive priority for development.

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What was proposed for this study was the development of a site visitation model that could be utilized in generating Hotelling-Clawson demand curves and ultimately site related dollar benefits. The demand curve approach to estimate site benefits was selected since the recreational use of public access sites has no fixed market price to determine dollar benefits for site use. By creating a series of site specific visitation equations, based on related studies conducted in Texas and Michigan and data gathered from 16 lake public access sites during the summer of 1975, the visitation estimation model for this study was developed. The equation used for the model is given below.

$$Y + C = A X_1^{B_1} X_2^{B_2} X_3^{B_3} X_4^{B_4} X_5^{B_5}$$

Y = Number of annual visitors to the access site (from origin "time zone").

C = Constant (Usually 1.0) used with double logarithmic transforms of the data.

X₁ = Time zone population (origin).

X₂ = Travel costs (converted time increments).

X₃ = Average family income.

X₄ = Gravity variable (alternative water-based recreational opportunities--around site of visitor origin).

X₅ = Surface lake acreation (destination).

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By developing the 16 "site specific" visitation equations, and using multipliers to expand the data to annual site visitations, a total of 622,737 annual visitors was predicted. By increasing the value of the travel cost variable incrementally, 16 "site specific" demand curves were created. The area of consumer surplus under each of the demand curves then represented the visitation related site benefits. The annual dollar benefits or consumer surplus for the surveyed sites totalled \$1,860,602.

After completing the estimations of site visitations and dollar benefits for the study's surveyed sites, the 16 "site specific" equations were combined into three separate series of visitation predicting equations: (1) "state-wide"--a single equation combining data from all survey respondents, (2) "regional"--two equations, each combining data gathered of survey sites in the upper and lower regions of Michigan's lower peninsula, and (3) "sub-regional"--four equations, combining data from survey sites on a sub-regional basis. After testing the three series of combined equations for predictive accuracy (using visitation data from sites with vehicle counters), the "state-wide" single equation was selected for use in predicting site visitations at non-surveyed existing public access sites.

By applying the single combined visitation equation to the existing 339 lake public access sites (60

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percent of all Waterways Division public access sites) a total of 5,741,774 estimated visitors was projected. The totalled figures for visitations represents 68 percent of the counter count annual visitations set at 8,466,390. The total site benefit figure for all 339 lake access sites totalled \$20,341,473. The above dollar figure represents the site benefits generated by annual visitations to the existing lake sites in Michigan's lower peninsula.

The model as conceived does not give consistently accurate individual site visitation projections for site development planning. Additional refinement is desirable before the model is used for this purpose. A number of variables should be sought out to improve the model's predictive power. One variable that should be explored for inclusion in the model is "site attractivity."

This dissertation is dedicated to
my daughter,

Holly Michel Warner

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The list of individuals who were instrumental in the success of the Public Access Site Benefit Estimation Study and this resultant dissertation, represents literally thousands of people. However, to narrow this list down to the key contributors, I must start with Dr. Donald Holecek, my research supervisor. Dr. Holecek has proven to be invaluable as a source of information on economic theory and application of this theory to determine site specific recreational dollar benefits. It has truly been a learning experience for me to work with this man. In the same light, I must thank Dr. Lewis W. Moncrief, my Ph.D. Degree Committee Chairman, for his review and recommendations of this research project. The remaining Ph.D. Committee members who have guided me in both this research effort and in the classroom setting are: Dr. Michael Chubb from the Geography Department, Dr. Eckhart Dersch from the Department of Resource Development and Dr. Robert McIntosh from the School of Hotel, Restaurant and Institutional Management.

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CHAPTER I

STUDY ISSUES AND RESEARCH PROBLEM

Introduction

Since 1939, when the State of Michigan ushered in the "Public Fishing Site Program," various Divisions under the Department of Conservation (now the Department of Natural Resources) have worked to provide increasing access to this state's water resources. The "Fishing Site Program" was sponsored through increases in fishing license fees and was designed to provide "walk-in" access only, to inland water bodies.¹ After World War II, Michigan experienced a marked increase in the number of recreational boats throughout the state. As the number of boaters increased, so did the pressure on the public access sites. The initial sites had not been designed to handle trailered craft with their requirements for launching ramps and parking facilities.

Through the decades of the 1950's and the 60's, the boat population continued to grow at an ever increasing rate. By 1968, to more adequately meet the needs of

¹Outboard Boating Club of America. Proceedings: Sixth National Conference on Access to Recreational Waters. (September 1969, p. 12.)

the boaters, the state's Public Access Program was shifted to the Michigan State Waterways Commission. The commission was able to increase its operating budget to handle the new program through allocations from the state's marine fuel tax. With the transfer of administrative responsibility, the newly acquired sites are now being developed to accommodate the large number of trailered and car-top craft. However, with over a half a million registered boats in the State of Michigan (59.7 percent transported at least once annually)² and an additional 100,000+ craft (not requiring registration) attempting to gain access to the state's water bodies, the Waterways Commission and its operational division have a sizeable task in providing adequate public access.

Like all public agencies, the Waterways Division operates on a limited budget. The problem then is how can the division in the face of spiraling demand allocate its limited funds on the Public Access Site Program in order to obtain maximum benefits for Michigan boaters? The site acquisition problem was brought to the forefront in June of 1970, when Governor William Milliken imposed a ban on further acquisition of Public Access Sites until criteria for the selection of such sites could be reviewed and approved. The research staff and public access site

²Recreation Resource Consultants, 1974 Michigan Recreational Boating Study (East Lansing, 1975), p. 36.

administrators put together a "Statement of Public Access Site Land Acquisition Program Criteria" to lift the ban on site acquisition. The site acquisition criteria statement was completed in 1971, and, upon accepting it, the Governor lifted his ban on acquiring new sites.

Since the first "criteria" statement which considered in broad terms: (1) magnitude of anticipated use, (2) feasibility of acquisition, (3) ecological considerations, (4) safety and regulation, (5) increased satisfaction or quality of experience, (6) interprogram effects, (7) resource preservation, (8) cost effectiveness, (9) secondary benefits, and (10) equitable distribution of facilities, revisions were made to clarify the importance of each of the above factors.³

The question that arose within the Waterways Division was "how useful were the initial site selection criteria when none of the factors were quantified?" In order to increase efficiency in the public access site selection process, a second "selection criteria" was developed. The second criteria emphasized that "acquisition and development efforts will be guided by our desire to provide for the greatest number of recreational

³Michigan State Waterways Division. "Statement of Public Access Site Land Acquisition Program Criteria." (Lansing: Michigan Department of Natural Resources, 1971).

opportunities for the fewest dollars expended."⁴ In order to carry out this planning directive, the second site acquisition criteria was developed around the following factors: (1) the existing availability of public access to the lake, (2) proximity to population centers, (3) potential for recreation opportunities, (4) lake size, shape and island influence, (5) geographic distribution of opportunities, and (6) proximity to public road system.

The components of the second "site selection criteria" seem to be based upon widely accepted factors which explain levels of site usage. Because of the immediate need and lack of alternatives, the existing lake ranking system is based upon a subjective numerical scaling, and does not rest on data derived from sound research efforts.

Problem Statement

The Michigan State Waterways Division, in its ongoing research program, has recognized the need for a detailed study to determine the dollar benefits which accrue to the public who use lake access sites. Such a study would: (a) document visitations at selected existing sites; (b) establish demand functions for lakes with existing sites; (c) provide for extrapolation of the demand curves to lakes where public access sites are

⁴Michigan State Waterways Division. "Inland Lake Acquisition Priority." (Lansing: Michigan Department of Natural Resources, December, 1972).

proposed; and (d) allow for the measurement of dollar benefits and cost effectiveness for existing and/or proposed public access sites.

Through the development of the site visitation and demand estimation model, the Waterways Division would have a tool to use in selecting future sites more effectively than is now provided through the use of the existing "weighted site selection criteria." The division, as indicated earlier, has assumed a large task in providing access for the boaters in the State of Michigan. The question of where public dollars should be spent for access site development should be addressed more rigorously than is possible with the existing subjective system. It is toward development of this more rigorous decision-making tool that this study is focused.

Objective of the Study

The primary objective of this study is to determine the dollar benefits which can be attributed to annual visitations to Michigan State Waterways Division administered public access sites.

The region of the state to be studied includes all of Michigan's lower peninsula taking in Department of Natural Resources' Regions II and III (see Figure 3). The reasoning behind the selection for study of only two of the state's three regions will be stated under the Research Administration section of this dissertation.

The data gathered and the models developed will be utilized by the Michigan State Waterways Division to:

- (1) help determine the overall cost-effectiveness of their existing public access site program, and
- (2) provide a method for selecting new sites to add to the existing system.

Variables used in the estimation of a site's annual dollar benefits will incorporate quantified elements currently used for site selection and listed in the Waterways Division's Second "Criteria on Site Selection" (see page 3). Upon estimating annual visitation and developing demand curves for surveyed sites, a multiple regression equation will be created which will be used to estimate annual visitation at non-surveyed sites. Once total annual benefits are determined, a comparison with annual costs can provide a benefit/cost ratio for the existing site program.

The direct costs incurred by the Waterways Division are to be computed by the Waterways Division engineering staff. Beyond providing the Waterways Commission with information related to existing program efficiency, the resultant study model, once tested, should strengthen the existing criteria for future site selection since it can be used to estimate potential benefits from new sites.

CHAPTER II

RESEARCH DESIGN

Review of the Literature (Estimating Recreation Dollar Benefits)

The main task of this research project, as previously outlined, was the determination of recreational benefits which accrue to inland lake public access sites. The benefits or "dollar value" for site visitations has been historically difficult to determine because, as is often the case with publicly provided recreational opportunities, fees are not charged at most sites in the system. Without related market price data (i.e. entrance fees) for the recreational experience, estimations utilizing substitutes for market prices or politically set dollar valuations are then used as surrogates in determining project benefits.⁵

The literature review for this dissertation provides basic background on selected approaches utilized in estimating site related recreational benefits. Three distinct valuation approaches are presented, and some of

⁵A. A. Schmid, "Analysis of Non-Market and Distribution Effects." Course Notes: RD 811/Public Program Analysis, Michigan State University, 1975.

their strengths and weaknesses are discussed. The three approaches will be compared in an effort to show the selection process used to determine the most appropriate valuation estimation method for this study.

The three site valuation approaches discussed in this literature review are: (1) Single Value Criteria, (2) Willingness-to-Pay, and (3) Imputed Demand Curves. It should be remembered that the above site valuation approaches as well as others, are utilized in the public sector to aid in determining which public projects should be undertaken. By setting standards by which dollar benefits can be estimated, projects can be ranked according to benefit/cost ratios. The establishment of project benefit estimations is essential for the resource manager in the decision making process: which project has the highest ration of benefits over costs.

Single Value Criteria:

The single value criteria approach is often utilized when in-depth site valuation studies have not been made (i.e. project fund restrictions) prior to actual resource management decisions. This approach utilizes a politically established value per visitation to a specific site. An example of this would be the action taken by the U.S. Congress in 1964 in establishing a value range of \$.50 to \$1.50 for most recreational activities on a

unit day basis.⁶ A range in values was selected to reflect the amount of development across the sites in the system. The range of values set by Congress in 1964 for specialized recreational activities was from \$2.00 to \$6.00 per unit day.

In 1973, the U.S. Water Resources Council increased the values of both general recreational experiences (\$.75 to \$2.25/day) and specialized recreational activities (\$3.00 to \$9.00/day).

Below are the steps taken by the Bureau of Outdoor Recreation (utilizing the "single value" approach) to estimate project benefits:⁷

- (1) Estimate the zone of influence of the project.
- (2) Determine the present and future populations that would probably be served by the recreation area.
- (3) Estimate visitor-days or activity occasions for each activity within the study area during the life of the project.
- (4) Standard values are then attached to participation by activity and the resulting number represents an unweighted benefit of those activities. Values per day range from \$.75 to \$9.00 depending on whether the activity is strictly routine or of a highly specialized type.
- (5) The values so obtained are then weighted up or down depending on such factors as water quality, scenic beauty, etc... which vary from site to site.

⁶Jack L. Knetsch. Outdoor Recreation and Water Resources Planning, (Washington, D.C., American Geophysical Union, 1974), p. 65.

⁷Orris C. Herfindahl and Allen V. Kneese, Economic Theory of Natural Resources, (Columbus: Merrill Publishing, 1974), p. 262.

(6) The weighted value represents the benefits which will accrue to the facility and which are used in the benefit-cost analysis.

The utilization of the "single value" criteria has received considerable criticism for a number of reasons. The first being the lack of consistency in applying values of similar weight from one project to another. The ultimate goal of determining project benefits is to provide a measuring stick by which one project can be compared to another. The tendency has been that where politically priced recreational values are utilized, projects with equal degrees of development are not given equal benefit values. Just as the value scale itself was established on a subjective basis so is the application of the value scale often made on a subjective basis.

The second criticism of utilizing the single value criteria is the inability of this approach to take into account differences in demand curves from one recreational site to another.⁸ If two recreational sites attract 1,000 persons per day with no entrance fee and the congressionally set value for the experience is \$1.00 per person, the daily value for both sites is \$1,000. This \$1,000 figure is set and does not take into account variations in willingness-to-pay, which would produce value figures lower or higher than the fixed \$1,000 value.

⁸Knetsch, p. 66.

In an instance where little or no information is available for valuing a recreational experience or project, the "single value" criteria with its politically established values can be used, but only when its shortcomings in predictive accuracy are recognized. After reviewing this valuation estimation approach, utilizing set standards for benefits, it was decided that this approach would not be used for looking at Michigan public access sites.

Willingness-to-Pay:

A second approach used to determine the value of a recreational experience is called the willingness-to-pay approach. As the name implies, the user of a recreation area or facility is asked how much he would be willing to pay to continue using the site or to prevent the loss of the site. Knetsch compares willingness-to-pay between market and non-market goods in this manner:

In a market economy, resources are allocated to uses for which consumers are willing to pay a price that bids them away from alternatives; those uses for which the willingness to pay is insufficient will not be undertaken. Comparable to the role of price as an objective rationing device that ensures that goods and services end up in uses for which willingness to pay is the greatest, the criterion of an implied willingness to pay is equally applicable for commodities that are not allocated by means of competitive pricing.⁹

⁹Knetsch, p. 60.

Given willingness to pay information from a non-biased sample of site visitors, a site specific demand curve can be developed by extrapolating the sample information to the entire site user population. A considerable number of water resource related benefit/cost analysis studies in the past have utilized the willingness to pay approach to estimate project benefits. This approach is considered a guide for social choice since benefit estimations are developed through the site users own estimation of worth of the experience.

Although the willingness to pay approach to predict project benefits is widely used, this method does possess some internal weaknesses. A problem in determining willingness to pay for the use of an area, is extracting accurate data from the respondent. In the case of a public provided recreation area where no fees are charged, when asked "how much would you be willing to pay for a day's use of this site?" a respondent could answer "I don't pay anything now so I would not pay any amount to use the site."

If the respondent felt that the information being sought would be utilized to establish entrance fees to a site where no fees existed before, the individual's response would be intentionally low. On the other hand, if the respondent felt that more sites would be developed if he provided a high response, he would be inclined to

inflate his true willingness to pay. There is also a problem of the user being able to give a value for something for which he has never paid.

In utilizing this approach in a study, the difficulty is one of soliciting accurate data from the respondent. It is a problem that can only partially be solved through a well designed survey asking the same question, reworded, several times during the interview. In order to provide backup benefit estimations for this study, a substudy was carried out which collected and analysed willingness-to-pay data from Michigan public access site users.

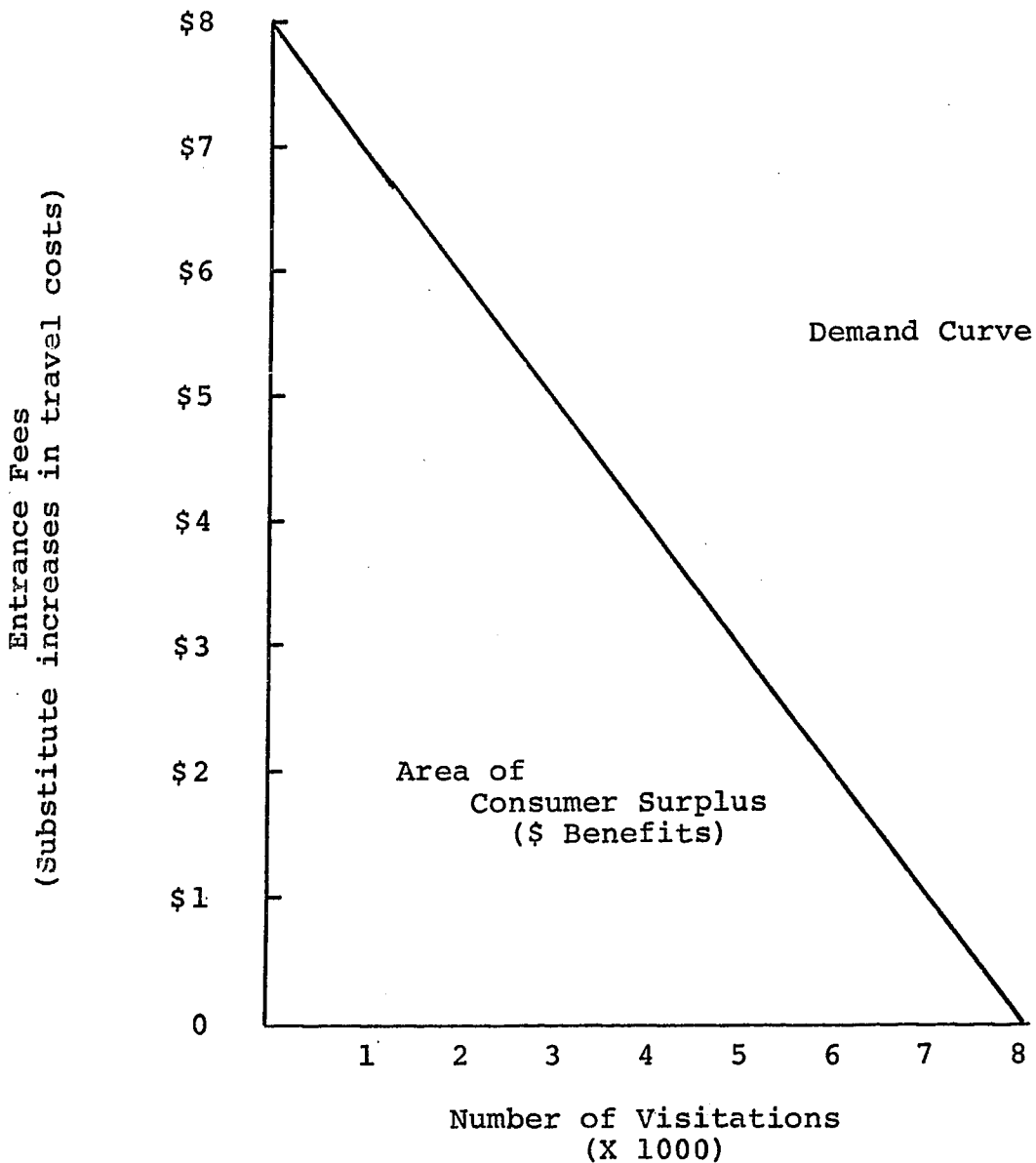
Imputed Demand Curves from Travel Cost Data:

The third and final method discussed here for estimating non-market priced recreational benefits is the "imputed demand curve" approach. This method utilizes expenditure behavior as a surrogate for prices. By creating a visitation prediction model for a site, demand curves can then be produced. The initial point determined on the demand curve is the total attendance with the price set at zero. By placing a series of increasing fees (corresponding to travel distance zones) into the model, sufficient points can be established to plot the entire demand curve.

The site benefits (referred to as "consumer surplus") related to visitations then fall under the area of the demand curve (see Figure 1, below).

FIGURE 1

Hypothetical Demand Curve and Area of
Consumer Surplus for a Recreation
Site



Consumer surplus is described as: "the surplus received by consumers from the purchase of some quantity of a good is the difference between the value of the utility they receive from that quantity of the good and the actual cost of that quantity."¹⁰ In this instance, the per unit value of a good (i.e. recreational experience) would reflect the highest price the consumer is willing to pay. This is referred to as perfect price discrimination. Since empirical measurement of price discrimination is usually not possible, a determined per unit price is set, with the consumer surplus value lying above the set price.

There has been considerable debate over the use of consumer surplus as the measure of total benefits attributable to a recreation site. However, a number of authors (some described below) have utilized the concept of consumer surplus in estimating recreation site dollar benefits.

The approach described above substitutes travel costs for price (i.e. entrance fee) in estimating recreation area demand curves. This approach was first suggested by Hotelling in 1949 and reported by Roy A. Prewitt in "The Economics of Public Recreation--An economic Survey of the Monetary Evaluation of Recreation in the National

¹⁰Walter Nickolson, Microeconomic Theory (Hinsdale, Illinois: Dryden Press, 1972), pp. 300-301.

Parks" in 1949.¹¹ Since the Prewitt article, a number of refinements in the travel cost imputed demand curve model have been made. In 1959 Marion Clawson looked at travel cost data related to visitation of National Parks in the western portion of the United States to determine site specific demand curves.¹² His resulting article, "Methods of Measuring the Demand for and Value of Outdoor Recreation," outlined his approach which is a refined Hotelling model.

Since 1959 numerous travel expenditure studies predicting recreation demand and valuation have been carried out by researchers in the recreation field. Of greatest relevance to this project is the "Texas Water Plan" study.¹³ The Texas study involved the estimation of the recreational value attributable to existing and yet to be created reservoirs. The underlying idea for estimating demand and dollar values is similar to the Clawson model: increased travel costs associated with distance reflect demand patterns similar to increases in entrance or park usage fees.

¹¹Marion Clawson and Jack Knetsch, Economics of Outdoor Recreation. (Baltimore: John Hopkins Press, 1966), p. 64.

¹²Ibid., p. 72.

¹³Texas Water Development Board, "Economic Evaluation of Water-Oriented Recreation in the Preliminary Texas Water Plan," (Austin, 1968), Report No. 84.

Table 1 below shows reaction of a three zone market area reflecting increases in travel distance.

Table 1.--Variation in Recreation Area Consumption by Access Costs.¹⁴

Zone	Population	Access Cost Per Visit	Number of Visitors	Visits Per 1,000 Population
1	1,000	\$1	500	500
2	4,000	\$3	1,200	300
3	10,000	\$5	1,000	100

Referring to Table 1, if there is no entrance fee, then 2,700 visitors (the sum of column 4) can be expected at the park. However, if a \$1.00 entrance fee is simulated by increasing the access cost by zone an increment of \$1.00, the expected result would be lower area attendance. The lower figure would represent one point on the imputed demand curve where the entrance fee equals \$1.00. Simulating increases in access costs until visitations reach zero, the additional points on a recreation site's demand curve can be produced.

The Texas study adopted the view put forth by Hotelling and Clawson that the area under the demand curve is the dollar benefit yielded by the recreation facility or the total willingness to pay for it.¹⁵

¹⁴Knetsch, p. 264.

¹⁵Ibid.

In order to create accurate estimates of site visitations, a survey of existing reservoir sites in Texas was conducted. The study determined where the visitors were coming from and their socio-economic characteristics. With the survey data on visitor characteristics as well as information on reservoir construction characteristics and alternate water-based recreational opportunities available to visitors, a model was created to predict reservoir visitations (the actual visitation model will be discussed at length in the following section of this paper).

The members of the study team concluded that by utilizing the basic approach set forth in the Texas Water Plan study and by injecting proper revisions to adapt the model to Michigan public access sites, estimation of site worth could be delineated. Both benefits attributable to existing sites and those sites yet to be developed could be calculated through one or a series of models. The procedures for gathering data and applying this information to the Michigan model/s will be covered under the "Research Administration" segment of this report.

This literature review has not attempted to cover all of the methods that have been utilized in estimating the benefits of non-market priced recreational opportunities. It has instead briefly covered three major valuation estimation approaches: (1) single value criteria

(politically set value), (2) direct willingness to pay, and (3) imputed demand curves from travel cost data. This review was designed to weigh the applicability of each approach in estimating the value of Michigan public access sites. It was felt that imputed demand curves utilizing travel cost data would provide the best valuation estimates. However, as indicated earlier, additional willingness-to-pay data was gathered as a measure of comparison.

The Research Model

The research model utilized in this study draws upon the work of two previously conducted studies. The first study, discussed in the literature review section of this dissertation, is the Texas Water Plan study on "Economic Evaluation of Water Oriented Recreation." The Texas study was utilized as a guide in the development of the site visitation estimation model. The second study, conducted by Michael Freed deals with the criteria for the selection of explanatory variables used in the Michigan model.¹⁶

The "research model" section of this dissertation will briefly review the work conducted in the two studies mentioned above. This review will outline the importance

¹⁶Michael Dale Freed, "Criteria for the Selection of Public Access Sites on Inland Lakes in Michigan," (Michigan State University: Ph.D. Dissertation), 1973.

each of the two studies had in developing the Michigan visitation estimation model for public access sites.

The Texas Water Plan Study outlined the procedure used to develop a site visitation estimation model. This model was ultimately used to predict reservoir site recreational benefits. The steps taken in the Texas study included: (1) the gathering of data from visitors at existing reservoir sites, (2) utilizing the collected data to create a series of site specific visitation estimation equations, (3) varying the travel cost variable in the equation, incrementally, to determine visitation levels at various prices (travel costs) for each of the existing reservoirs, (4) calculating the area under the demand curve to use as a value estimate (consumer surplus) for surveyed existing sites. (5) Combining the visitation equations developed for existing sites to create a single equation visitation estimation model, (6) applying the single equation model to yet-to-be developed reservoirs to predict site visitations and demand curves, (7) calculating the consumer surplus under the demand curves generated for the projected reservoirs.

As indicated earlier, the Texas study was designed to determine the recreational dollar benefits that could be attributable to yet to be constructed reservoirs. In the model building process, the following data was gathered at eight existing reservoirs:

- (1) Number in the party
- (2) Visitor origin county
- (3) Traveling time between visitor origin county and reservoir
- (4) Age group of head of party
- (5) Income group of head of party
- (6) Primary purpose of the trip
- (7) Occupation of head of party
- (8) Educational level achieved by head of party

The study utilized "counties" as the origin observation unit. A 100 mile radius was then established around each reservoir site, with those counties located within the 100 mile radius included for analysis.¹⁷ For each destination site (reservoir) a series of multiple regression equations was computed. Each equation was based on origin counties. The predicted visitations (Y's) for time zones represented the sum of the Y's for the counties in each zone. The equation with its variables is listed below.

$$(Y_{ij} + 0.8) = a \quad x_1^{b_1} \quad x_2^{b_2} \quad x_3^{b_3} \quad x_4^{b_4} \quad x_5^{b_5}$$

Y_{ij} = Number of visitor days from the origin county i to reservoir j.

j = 1...8; i = 1... all counties within 100 miles of lake j.

X_1 = Population of the origin county.

X_2 = Round trip cost of travel.

X_3 = Per capita income in origin county.

¹⁷The 100 mile radius in the Texas Study covered 95 percent of all site visitations to existing reservoirs.

X_4 = Gravity variable (existing reservoir acreage within 100 miles of origin county).

X_5 = Surface acres of destination reservoir.

Since theoretical relationships exist between the selected independent variables, the multiple regression equation is multiplicative rather than additive. The study equation then is linear in the parameters (coefficients and exponents) but is curvilinear in the variables. A double logarithmic transform was carried out on the data to allow analysis of the data in a linear form. The constant 0.8 was added to the dependent variable Y to aid in determining demand curves at the origin (zero visitors) since the logarithm of zero is undefined.

To determine site visitation when the user fee is zero, the solution for each equation (based on origin county data) was determined and the sum of county equations out to 100 miles provided the visitation figure. In order to obtain additional points on the site demand curve, the travel cost variable was increased incrementally. Once the demand curve for the site was computed, the dollar benefit estimate for that site was derived by calculating the area under the curve.

In order to predict site visitations at non-existing reservoirs, the sample data for all eight surveyed reservoirs was combined into a single equation. By applying data related to proposed sites to the aggregate

equation, visitation estimates and dollar value estimated could be computed using the iterative approach outlined for existing reservoirs.

Since the model developed in the Texas study appeared theoretically sound and since it had been proven to be operational, it was selected as a guide for the study discussed herein. What had to be determined prior to the collection of data from the field was the applicability of the independent variables included in the Texas model to a Michigan setting.

The need for information on visitations to Michigan public access sites lead to the study conducted by Freed. In 1973, Michael Freed completed a Ph.D. dissertation at Michigan State University entitled, "Criteria for the Selection of Public Access Sites on Inland Lakes in Michigan." Freed in this study, identified a number of variables which explain in part public access site visitations in Michigan.

The following variables were found to be significant in predicting Michigan's public lake site visitations.

1. Mooring facilities $R^2 = .5190$
2. Number of registered boats $R^2 = .0005$
3. Number of angler days $R^2 = .3143$
4. Number of seasonal homes $R^2 = .0158$
5. Acres of lake surface $R^2 = .0067$
6. Number of public campsites $R^2 = .0028$

7. Disposable income $R^2 = .0059$

8. Parking spaces at public access sites¹⁸
 $R^2 = .0031$

Freed's study, as in the Texas study, used county units in the analysis of site of origin data. In order to improve on predictive accuracy of the Texas model, smaller sections of individual Michigan counties (Michigan Department of Transportation "Time Zones")¹⁹ were selected for the "Benefit Estimation" study covered by this dissertation.

The Michigan Highway study breaks the 83 counties in Michigan down into 508 individual "Time Zones" (see Figure 2). The Michigan "Time Zones" should not be confused with the concentric rings of counties used in the Texas study for time zones. The use of Michigan "time zones" improves accuracy in determining the geographic distribution of site users, income distributions and other additional variables used in the model. Aggregation of data on a county basis is in this way eliminated.

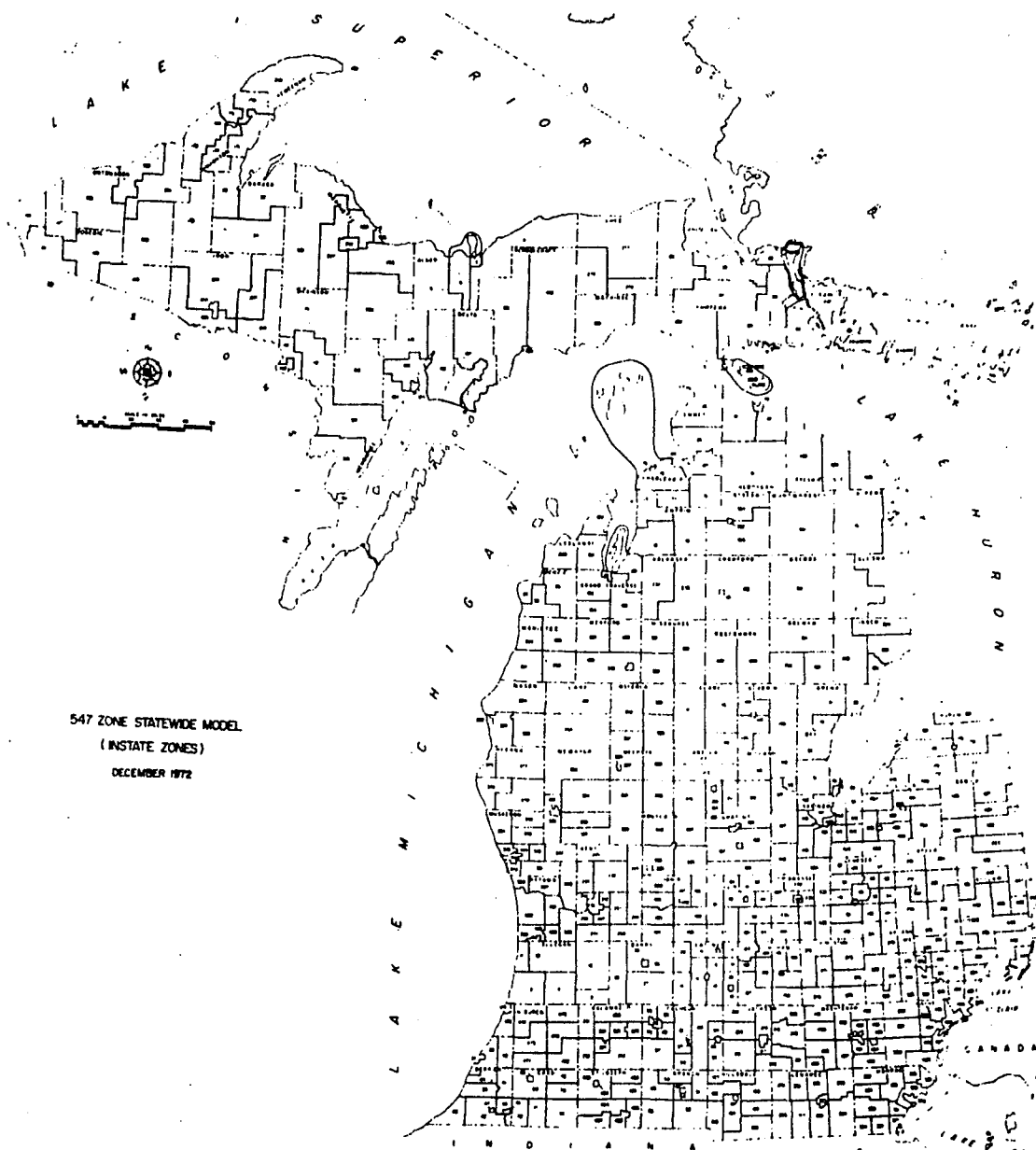
Since the study described by this dissertation utilized Michigan Highway Department "Time Zones," not all variables listed by Freed as significant in predicting access sites visitations could be utilized in the model.

¹⁸Freed, p. 51.

¹⁹Michigan Department of State Highways, Statewide Transportation Analysis Research (Lansing, Michigan, 1973).

FIGURE 2

MICHIGAN DEPARTMENT OF
TRANSPORTATION INTRASTATE ZONES



The data had to be available on a Michigan "time zone" basis. After reviewing the information available on a "time zone" basis, the following variables were selected for preliminary inclusion in the Michigan site visitation equation:

$$(Y + 1.0) = x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5} x_6^{b_6}$$

Y = Number of visitors (at selected lake site)

X₁ = Time Zone population

X₂ = Travel Cost (2X distance from the center of the origin the zone X 20¢ per mile)

X₃ = Average Family Income for Origin time zone

X₄ = Gravity Variable (lake acreage, stream and Great Lakes shoreline miles within two hours of origin time zone)

X₅ = Lake Acreage (destination site)

X₆ = Number of parking spaces at destination site

Of the above variables, income and lake acreage data were used in both the Texas and Freed studies. Travel costs, "time zone" population and the "gravity" variables, were taken from the significant variables found in the Texas study. The parking space variable was selected from the Freed study, but was questionable in its impact in the visitation model.²⁰ Part of the problem in correlation between parking spaces and site visitations in Michigan relates to the historical development of "walk-in" access sites.

²⁰Freed.

In reviewing the strengths and weaknesses of the proposed Michigan model, it should be remembered that the water bodies in the Texas study were manmade reservoirs. All of these reservoirs would have similar design characteristics so that the access site visitation patterns would vary primarily with the location of population centers. Because of the similarity of the Texas reservoirs, a single site visitation equation, applicable to yet-to-be constructed reservoirs, could be developed.

The model used to predict visitations to Michigan public access sites, unlike the Texas study, must take into consideration the vast array of differences among Michigan lakes. The lakes selected for the survey of site visitors in Michigan vary from a 39 acre mud bottom lake that is ringed by dead trees, to a 9,900 acre lake that has a sand bottom and is almost surrounded by managed state forest and park land. Unlike the Texas reservoir situation, each Michigan public access site is likely to be in a different recreational environment. A question should be asked: "How much will the variation in site characteristics affect the predicting accuracy of this study's visitation model?" The affect of variations of lake characteristics for the Michigan model is not known at this time. In order to deal with the variation in lake characteristics, it is possible that a series of site

prediction equations, instead of a single equation for the entire state, may be required to improve model predictive power.

Research Hypothesis

The primary hypothesis of this study is stated below:

Study Hypothesis: The monetary value of Michigan's public access sites can be determined through the use of imputed demand curves.

By adopting the Hotelling-Clawson method, which utilizes travel cost data as a substitute for site entrance fees, first site specific and then state-wide benefits attributable to the recreational use of public access sites will be estimated.

A series of related sub-hypotheses also provided direction in this study. The sub-hypotheses center on the independent variables reviewed for use in the site visitation equation.

Sub-Hypothesis #1: The population of the origin "Time Zone" (defined for this study as a segment of area within a single Michigan county) will register a statistically significant positive effect on site visitations.²⁰

Sub-Hypothesis #2: Visitations to Michigan public access sites are negatively correlated with the travel cost variable.

²¹The "time zones" utilized for this study are adopted from the Michigan Department of State Highways, Statewide Transportation Analysis and Research publication, 1973.

- Sub-Hypothesis #3: Visitations to Michigan public access sites are positively correlated with family income.
- Sub-Hypothesis #4: As alternative water based opportunities (gravity) increase around the origin "time zone" fewer visitors are expected at the destination site. Gravity then has a negative impact on site visitations.
- Sub-Hypothesis #5: As the lake size increases (destination site) the number of visitors will increase.
- Sub-Hypothesis #6: The greater the number of parking spaces per access site the greater the number of expected site visitations.

CHAPTER III

RESEARCH ADMINISTRATION

This section of the dissertation will cover the following research method components: (1) determination of the sample population of public access sites, (2) design of the survey instrument, (3) pretesting the survey instrument, (4) data collection from the field, and (5) data preparation prior to analysis. Steps 1 through 4 were initiated in May, 1975 and completed as of August 25th, 1975 when field data collection terminated.

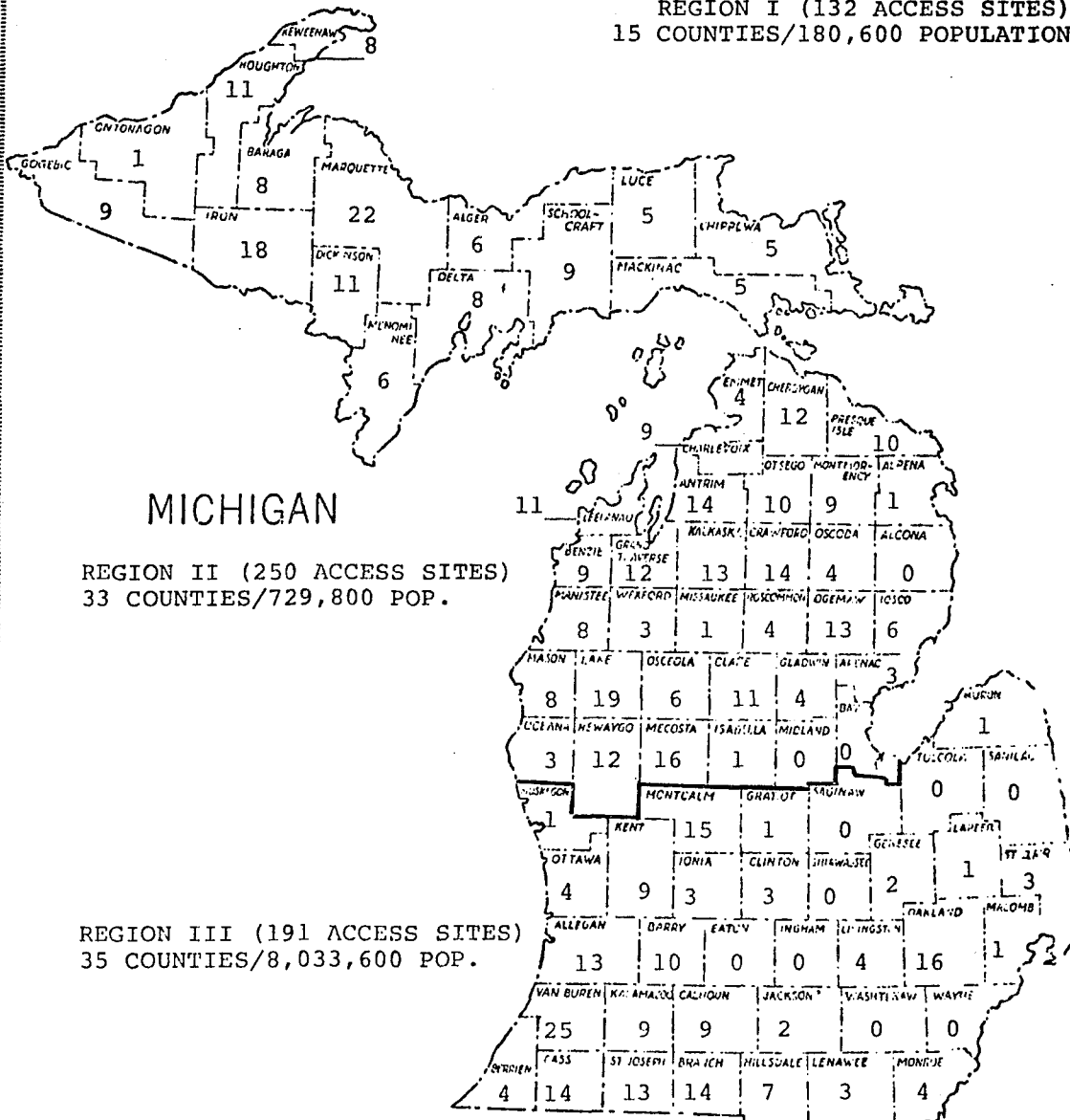
Determination of the Sample Population of Public Access Sites

In order to estimate site visitations and ultimately site benefits, it was necessary for this study to select a number of existing public access sites in the state for survey purposes. In all, the Michigan State Waterways Division administers 573 public access sites, which include inland lakes, streams, rivers and the Great Lakes. (See Figure 3, on the following page.)

Since this study deals specifically with the lower peninsula of the state (Department of Natural Resources Region II and III) and inland lake sites only, the total

FIGURE 3
WATERWAYS DIVISION ADMINISTERED
PUBLIC ACCESS SITES

REGION I (132 ACCESS SITES)
15 COUNTIES/180,600 POPULATION



population of sites for visitation and benefit estimation is limited to the 339 inland lake sites that exist in this study area. The Waterways Division maintains vehicle counters at 35 of the 441 lower peninsula public access sites (see Figure 4). These 35 sites were selected to reflect: a range of lake acreage, amount of site development, proximity to population centers and alternative water-based recreational opportunities.

In order to select lake sites with the electronic vehicle counters (used as 24 hour data compilers on visits) and stay within the proposed budget, it was determined that a total of 16 sites could be selected. The selection of the 16 sites (see Figure 5) was made in a manner to reflect the broadest possible range of the following: (1) lake acreage, (2) proximity to population centers, and (3) the availability of alternate water bodies. By collecting visitation data from these 16 selected sites, the sum of visitation equations then represents a composite for the entire lower peninsula access site system.

Design of the Survey Instrument

In order to assure a high response rate while obtaining visitation information, two methods for eliciting data were considered. First, a questionnaire could be handed to the site user with directions to return it "filled in" before leaving the site. Second, a survey instrument could be used in a person to person interview.

FIGURE 5

MICHIGAN STATE WATERWAYS DIVISION
SITES SELECTED
FOR THE VISITOR SURVEY

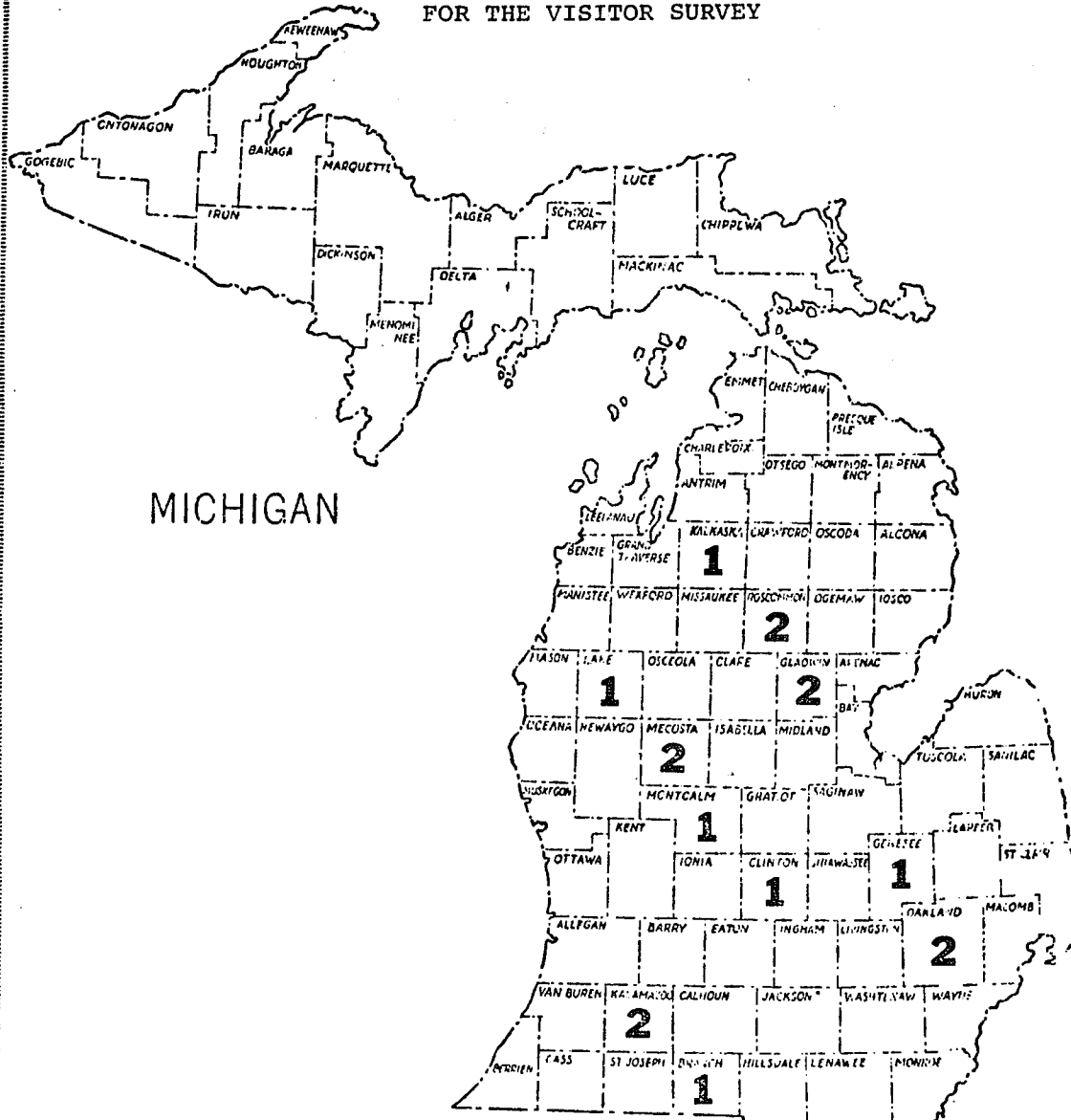
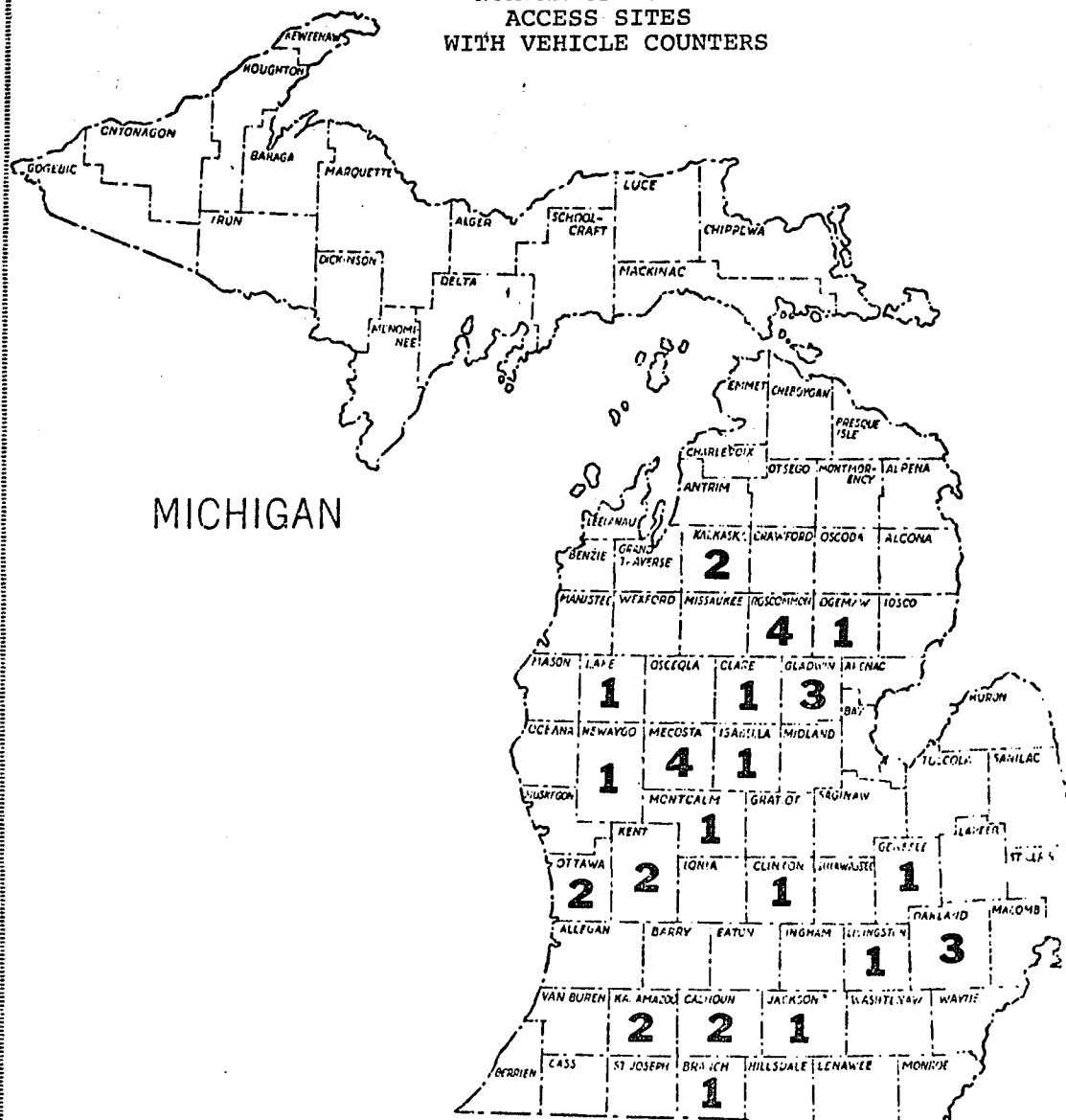


FIGURE 4

MICHIGAN STATE WATERWAYS DIVISION
NUMBER OF PUBLIC
ACCESS SITES
WITH VEHICLE COUNTERS



Since the data needed was not extensive and since "hand-out" questionnaires generally illicit lower rates of response than personal interviews, the person to person interview method was selected.

The survey instrument (see Appendix B) was designed to fit on two pages of 8½" x 11" paper. The back page which was filled out by the research assistant in the field provided the following information:

1. Observation by Research Assistant
 - A. Site and Survey Information:
(filled out prior to interview)
 - (1) Site number
 - (2) Respondent number
 - (3) Date of interview
 - (4) Day of week
 - (5) Weather conditions
 - (6) Time of interview
 - B. Site Visitor Information:
(filled out prior to interview)
 - (1) Did the party bring a boat on the site
 - (2) Number in party
2. Person to Person Interview
 - A. Site Visitor Information
 - (1) City of residence
 - (2) County of residence
 - (3) State of residence
 - (4) Distance traveled to the public access site
 - (5) Travel time
 - (6) Do you currently reside on a lake
(non-study related information--
requested by Waterways Division Staff)

Personal information (i.e., family income) to be collected from the respondents was filled out by the

respondent after a clipboard, with the instrument (questions located on the front page of the instrument) and a marking pencil, was handed to the site visitor. This approach was taken to reduce expected hesitancy to providing personal socio-economic status data. The first line of the instrument read: "Please check a single response to each of the five questions below. Your response remains completely anonymous according to strict University research codes." Following these instructions and the assurance of anonymity, five questions were asked on the survey instrument:

3. Respondent Writes in Answers

A. Socio-Economic Status Information:

- (1) Primary use of the site (nine categories)
- (2) Number of people in immediate family
- (3) Educational level achieved by head of household
- (4) Annual family income/before taxes
- (5) If this site was not available for use, how many miles would you be willing to travel to utilize a site of similar quality?

The fifth question was designed to provide data related to the visitors "willingness to pay" to use the site. The willingness to pay information provides a back-up estimation for site benefits collected in this study.

To assure a high response rate, the survey instrument was designed to be administered with minimum time being spent with each respondent. Since the site visitors would be anxious to participate in some water-based

recreational activity, administration time was deemed important. Also, by letting the respondent fill in the socio-economic status information, it was felt that a higher response rate would be achieved, since individual confidentiality was assured.

Pre-Testing the Survey Instrument

Once the initial survey instrument had been designed and all questions had been reviewed by research staff members for accuracy of meaning and predicted response, the instrument was taken into the field for pre-testing. The pre-test was conducted to see whether or not the questions could be understood by the respondent and if understood would the answers given provide usable data. The pre-test also provided an indication of the amount of time needed to administer the instrument and the method to be used when approaching the respondent (at entrance gate, while launching the boat, after launching the boat, etc.).

Muskrat Lake in Clinton County was selected for survey instrument pre-testing. The lake is the smallest of 16 selected survey sites: only 39 acres. Even though the lake is small, it attracts a sizable number of access site visitors (primarily fisherman) annually. The lake's popularity is likely due to its location in a portion of the state containing relatively few lakes. The 10th and 11th of May (Saturday and Sunday), 1975, were selected as test days.

The results of the pre-test indicated that of the 31 individuals surveyed over the two day period there were no recognizable problems in respondents understanding the questions or providing responses. The time required to complete an individual interview was less than two minutes on the average. One visitation trend that showed up over the test weekend was the number of people just using the site as a turn around area. During the two days, nine motorized vehicles used the site to turn around and were not surveyed.

Data Collection

In order to collect data from the 16 selected survey sites, four graduate assistants in the Department of Park and Recreation Resources at Michigan State University were hired. Each of the graduate assistants was assigned to conduct surveys at four public access sites. During the months of June, July and August, each site was attended on a once a month basis. A schedule was made out for each interviewer specifying which of his assigned sites should be manned during each specific week of the summer sampling period. The days and hours of each week during which he would conduct interviews was outlined. A scheduling example for one interviewer for the month of June is listed below:

Time Shifts:	#1 (6:00 AM - 2:00 PM)	PUBLIC ACCESS
	#2 (12:00 PM - 8:00 PM)	SITE STUDY

Schedule for Interview
(Sample)

	JUNE	TIME SHIFTS
HIGGINS LAKE (Roscommon County)	June 6 - Fri.	2
	7 - Sat.	1
	8 - Sun.	2
	9 - Mon.	1
LAKE ST. HELEN (Roscommon County)	June 13 - Fri.	2
	14 - Sat.	1
	15 - Sun.	2
	16 - Mon.	1
WIGGINS LAKE (Gladwin County)	June 20 - Fri.	2
	21 - Sat.	1
	22 - Sun.	2
	23 - Mon.	1
WIXOM LAKE (Gladwin County)	June 27 - Fri.	2
	28 - Sat.	1
	29 - Sun.	2
	30 - Mon.	1

The selection of access sites for specific weeks of the month was decided on a random basis. There was no attempt made to continue a set pattern, though interviewers were not permitted to work the same site two weeks in a row.

The days of the week that were selected for data collection were influenced by two factors. The first factor was the determination that the research budget was sufficient to fund only four eight hour days of interviewing per month per site. The second influencing factor was that data from the previous year revealed that 60 to 80 percent of site use occurred on Fridays, Saturdays and Sundays. To minimize travel cost and stay within the

research budget, it was necessary to conduct interviews during four consecutive days on each site once per month. Given the above considerations, it was decided to conduct interviews on Friday, Saturday, Sunday and Monday in June and July. In August, the interview period was Thursday through Sunday. No data was collected on either Tuesday or Wednesday during the interviewing period, however, counter information for each of the sites provided a source of data on visitations over these days. For analysis, visitation patterns for Tuesdays and Wednesdays were assumed to be the same as that determined for Monday and Thursday.

In designing the methods used to collect the site visitation data, it was necessary to decide what eight hours per day should be devoted to interviewing. Instead of running a single eight or ten hour shift in the middle of the day or three over-lapping shifts over the three month period, it was decided that two different eight-hour shifts would be utilized. As was seen in the earlier "Schedule of Interviews" example, the time shifts ran from 6:00 AM to 2:00 PM and from 12:00 PM to 8:00 PM. In both instances a site use fringe would be picked up (early morning and evening use). The over-lapping of the two shifts took place between 12:00 PM and 2:00 PM on the start of the afternoon.

In order to determine the number of site visitors to be sampled, counter data for the 16 survey sites was reviewed. For 1974, between May 17th and November 1st, a total of 130,000 vehicles entered the 16 survey sites. By running the survey on a four day a week schedule, eight hours each day, it was estimated that some 6,000 visitors would utilize the sites while interviewers were present. For analysis purposes, it was decided that surveying half of the 6,000 visitors would provide statistically significant data. The interviewers were instructed for the month of June to survey every other site visitation (vehicle entering the site). Upon meeting with the four interviewers prior to the start of July data gathering, two of the 16 sites were producing extremely low visitation figures. To insure that enough observations were collected to permit statistical analysis, the sample frame for July and August for these two sites was changed so that every party entering the site was interviewed.

In addition to interviewing site visitors, counter data was gathered by the four graduate assistants to test the accuracy of the counter mechanisms. Since the four day per month data was to be expanded to cover all 30 or 31 days of the month using counter data, the counter readings had to be verified. In order to test the counter accuracy, the counter was read by the interviewer at the start and end of each eight hour shift. Between the daily

check periods, the number of parties surveyed should equal half the counter count. (The daily log utilized for recording counter counts, and additional data on visitors bringing boats to the site is provided in Appendix C).

Data Preparation Prior to Analysis

As the survey data was being collected from study site visitors, completed survey instruments were sent back to the Recreation Research and Planning Unit at Michigan State University to be processed. Two work/study students were hired to transfer all information from the survey instrument onto "mark sense" computer forms. These forms were read and data cards punched mechanically, thus avoiding the time-consuming manual keypunching process.

After all the survey instrument data had been transferred onto computer cards, this data was then transferred to magnetic tape for processing convenience. With all of the survey data on tape, analysis could then begin in an efficient manner.

CHAPTER IV

ANALYSIS OF DATA

Introduction

The "analysis of data" chapter of this dissertation covers: (1) a brief review of the cross tabulation of collected survey data, (2) the multiple regression analysis (visitation estimation) of the surveyed sites, (3) the creation of demand curves for the surveyed sites, (4) the estimation of the dollar benefits (consumer surplus) for the surveyed sites, (5) the determination of combined site visitation equations, (6) the application of the combined visitation equation to non-surveyed existing public access sites, and (7) application of the study model to proposed public access sites.

The first section of this chapter, the cross tabulation of survey data, outlines information applicable to the study model as well as providing some information relevant to visitation patterns of Michigan public access sites.

Cross-Tabulation of the Public Access Site Survey Data

As was stated earlier in the Research Administration chapter of this paper, by using previous year counter

data, it was expected a total of 3,000 site visitors would be interviewed, given the selected survey periods. After twelve weeks of in-the-field survey work, a total of 2,601 site users were interviewed. This figure closely approached the estimated number of site visitors that were to be interviewed.

The following cross-tabulated data represents the summed data for all 16 surveyed sites. The site by site breakdown for survey data cross tabulation is provided in Appendix D.

Day of the Week Interviews
were Conducted

During the summer 1975 survey period, each of the 16 selected public access sites was manned a total of 12 days (one four day period for each of the three survey months). Table 2 below indicates the total percentages of interviews broken down by day of the week.

Table 2.--Cross-Tabulation Number and Percentage of Interviews at 16 Sites by Day of the Week.

16 Sites	Mon- day	Thurs- day	Fri- day	Sat- urday	Sun- Day	Total
Number of Interviewed Parties	241	230	675	688	767	2601
Percent of Interviewed Parties	9.2%	8.8%	26.0%	26.5%	29.5%	100%

It should be noted that the number of days interviews were conducted on Thursdays (three days) totaled only one-half those conducted on Mondays (six days). In order for the expanded sample visitation data to represent total annual visitations, the Monday through Thursday expected visitations would be averaged and then compared with site counter data. As is explained later in this chapter, the survey data was not expanded to provide an estimate of annual visitations, but rather the counter counts were utilized.

Time of the Day that Interview was Conducted

Since the interview schedule consisted of two different eight hour shifts (6-2 and 12-8), there is overlapping of visitor interviews during the 12:00 to 2:00 PM period. Specific weights were not assigned to the 12:00 to 2:00 time period. By not weighting this two hour period it is hypothesized that the sample is possibly biased toward persons traveling greater distances. This bias might effect the final estimation of site benefits by overestimating dollar benefits. Table 3 indicates the averaged results of the 16 surveyed sites.

Did Site Visitor Bring a Boat to The Public Access Site?

To estimate specific site benefits related to the use of Michigan State Waterways Division administered

Table 3.--Cross-Tabulation Number and Percentage of Interviews by Time of Day.

Time/AM	Number of Sampled Parties	% of Total	Time/PM	Number of Sampled Parties	% of Total
6 - 7	54	2.1%	12 - 1	376	14.5%
7 - 8	86	3.3%	1 - 2	379	14.6%
8 - 9	74	2.8%	2 - 3	211	8.1%
9 - 10	87	3.3%	3 - 4	209	8.0%
10 - 11	117	4.5%	4 - 5	185	7.1%
11 - 12	344	13.2%	5 - 6	180	6.9%
Noon			6 - 7	157	6.0%
			7 - 8	142	5.5%

public access sites, it is of considerable importance to distinguish between boaters and non-boaters. Since the Waterways Division's public boating site access program is funded through taxes on marine fuels, users who purchase marine fuels pay for development and use of the sites while those users who do not purchase marine fuels do not contribute significantly to the public access site system. Site benefits generated by non-boaters then would reflect benefits created for this segment of the public for which they pay nothing (no fees and no marine fuel taxes).

As can be seen in Table 4, the number of visitors bringing boats to the sites and those not bringing boats is almost identical.

A Chi square test was run to test for any significant difference in distance traveled to public access

Table 4.--Cross-Tabulation of People Bringing Boats to Public Access Sites.

	No Boat	Boat to Site	Totals
Number of Interviewed Parties	1281	1320	2601
Percentage	49.3%	50.7%	100%
	Trailered		Car-Top
Number of Interviewed Parties	1149		171
Percentage	87%		13%

sites for the surveyed boaters and non-boaters. The test indicated no significant difference between the two groups. The implications of this test on the breakdown of site benefits will be discussed later in this chapter.

Travel Time to Destination Site

The data gathered on the amount of travel time that site visitors incurred in coming to the destination site is a key variable for this study. The information on how far an individual would travel to use a site established cut-off limits for analysis of both the travel time variable and gravity variable. Table 5 indicates the number of parties surveyed broken out by 15 minute travel zones.

Table 5.--Cross-Tabulation Travel Time to Destination
Public Access Sites.

	(15 Minute Intervals)								
	<15	15	30	45	60	75	90	105	120
Number of Inter- viewed Parties	1108	647	309	108	91	19	73	15	69
% of Total	42.7	25.0	11.9	4.2	3.5	0.7	2.8	0.6	2.7

The jumps in percentages in the 90 and 120 minute time interval groups is most likely tied to unequal geographical distribution of access site users. This is especially true for the eight sites in Region II of the state.

Site Use Categories:

For the purpose of generating data on site use benefits as they relate to the types of activities the visitors pursue on public access sites, each visitor interviewed was asked to indicate his intended primary use of the site. Table 6 below lists the number and percentage of visiting parties undertaking each activity.

The "other" category for site use, (representing over 10 percent of indicated use) consisted primarily of visitors coming to the site to look at the lake and watch the activity around the site.

Table 6.--Cross-Tabulation Number and Percentage of Primary Site Use Categories.

	Number of Interviewed Parties	Total %
Fishing	758	29.3
Pleasure Boating	683	26.4
Swimming	605	23.4
Other	269	10.4
Water Skiing	190	7.3
Picnic	39	1.5
Sun Bathing	28	1.1
Scuba Diving	11	.4
Hunting	4	.2

Number in Visiting Party

The number of persons in the interviewed parties provides the initial expansion in generating site visitors during the survey period. This information is then needed to establish the annual number of visitors to the site. Table 7 indicates the frequency distribution of party sizes observed during the field observation phase of this study.

Income Levels

In reviewing both the Texas Water Plan study on recreational site benefits for reservoirs and the Freed study on variables affecting Michigan public access site visitations, the "income variable" was found significant in explaining visitations. Cross-tabulation of survey data reveals the largest percentage of respondents in the

Table 7.--Cross-Tabulation Total Numbers and Percentages for Party Size.

Party Size	Number of Interviewed Parties	Total %	Total People in Interviewed Parties	Total %
1	317	12.3	317	4
2	887	34.3	1774	22
3	468	18.1	1404	17
4	387	15.0	1548	19
5	188	7.3	940	11
6	280	10.8	1680	21
7	31	1.2	217	3
8	18	.7	144	2
9+	<u>11</u>	<u>.4</u>	<u>99</u>	<u>1</u>
Total	2587*	100.0	8123	100

* 14 missing responses

\$10,000 to \$15,000 category (30.5%). The site visitors with family incomes of \$15,000 or less represented 51.5% of the respondents. Those site visitors making over \$15,000 annually represented 48.5% of all respondents. Table 8 below lists the results of the data cross-tabulation by income taxes.

Multiple Regression Analysis of the 16
Surveyed Public Access Sites

After cross-tabulation of the survey data had been completed, the next step taken was to analyze the selected data for the visitation equation variables, via a multiple regression routine. The computer routine used was one included in the Statistical Package for Social Sciences

Table 8.--Cross-Tabulation Total Number and Percentages
For Income Classes.

Income Classes (in thousands of dollars)	Number of Parties Interviewed	Total %
0 - 5	145	6.0
5 - 10	383	15.0
10 - 15	733	30.5
15 - 20	517	21.5
20 - 25	307	12.8
25 - 30	156	6.5
30 - 35	61	2.5
35 - 40	32	1.3
40 - 45	15	.6
45 - 50	15	.6
Total	2406*	100.0

*195 missing responses (refusals)

(SPSS). The application of the survey data to a multiple regression routine produced estimators for the unknown parameters of the site visitation model. Once the resulting model was tested for accuracy in predicting visitations (utilizing site vehicle counter data) at surveyed sites, the model was used to create demand curves which provided the basis for estimating dollar benefits generated by site visitations.

The ability of the study model to accurately predict site visitations is important since it impacts the estimation of site benefits. As will be seen in the following sections of this chapter, the estimation process for predicting recreational site benefits is straight forward

once the parameters of the model are properly identified, and it is producing acceptable visitation estimates. However, if the estimated visitation figure is inaccurate, so will be the site dollar benefit estimation.

The independent variables entered into the individual visitation estimation models for each of the surveyed sites were: (1) the population of the visitor's origin "time zone," (2) travel time between the origin "time zone" and the destination public access sites, (3) average family income, and (4) alternate water-based recreational opportunities around origin "time zone" (gravity).

The "gravity" variable incorporated the total lake acres within two hours driving time of the site visitors place of origin (time zone). This variable also included Great Lakes shoreline miles and boatable stream miles within the two hour driving distance of the origin "time zone." The equation form used to determine gravity is given below:

$$X_j = W_1 \sum_{i=1}^n \frac{\log_{10} S_i}{d_i} + W_2 \sum_{i=1}^n \frac{\log_{10} G_{le}}{d_e} \\ + W_3 \sum_{e=1}^n \frac{\log_{10} S_{Me}}{d_e}$$

where:

X_j = Gravity value for "time zone" j.

W_1 = Weighted value for inland lakes (value = 3).

S_i = Surface acres of lake i (within two hours driving time or origin zone j).

d_i = Distance between "time zone" j and lake i.

W_2 = Weighted value for Great Lakes shoreline miles (Value = 2).

G_{le} = Miles of Great Lakes shoreline in "time zone" e.

d_e = Distance between "time zone" j and "time zone" e.

W_3 = Weighted value for boatable stream miles (value = 1).

S_{me} = Miles of boatable stream miles in "time zone" e.

d_e = Distance between "time zone" j and "time zone" e.

The weights assigned to each of the water bodies were derived from boating patterns in Michigan and outlined in the 1974 Michigan Outdoor Recreation Plan.²¹ By using a double logarithmic transformation of the data, the combined variable was entered into the visitation multiple regression equation.

Independent variable 5 (destination site lake acreage) listed under the "design of the model" section of this dissertation, was omitted from the individual models. Since regression equations were being developed for each of the 16 surveyed sites, the value of the lake acreage variable would not change so the variable was omitted.

²¹Michigan Department of Natural Resources. 1974 Michigan Statewide Outdoor Recreation Plan. (Lansing, Michigan, 1974), pp. 77-78.

It was included in the combined site models discussed in detail later in this dissertation.

At this point in the study independent variable 6 (parking spaces at destination site) was dropped from the model. The Freed study found some significance in the contribution of number of parking spaces to visits at public access sites. However, this variable accounted for only a limited amount of variance ($R^2 = .0031$).²² The selection of survey sites for this "benefit estimation" study did not show a correlation between parking spaces and visitations (counter count data). Because the contribution the "parking spaces" variable would make in the prediction model was highly questionable, it was dropped from the equation.

The "Y" or dependent variable for the 16 surveyed site equations was the number of visitors that came to the destination site from a specific "time zone."

It should be remembered that unlike the Texas study, the Michigan study outlined here is not using site adjacent counties and summing county visitation estimations to achieve concentric visitation time bands around each public access site. Rather, as indicated under the chapter on Research Design, the Michigan Department of Transportation "Time Zones" (508 in total) are used in this study. By using separate "time zones" (portions of a

²²Freed, op. cit., p. 51.

county) a more accurate visitation prediction model should result. If county visitation equations are added together to form concentric time zones, the model will only indicate that from somewhere in the middle of that time zone, X number of visitors will originate. The problem centers on the aggregation of data. However, by utilizing smaller sections of the counties (Michigan Department of Transportation "Time Zones") accurate data reflecting the characteristics of the residents should improve the model predictions, since the existing geographical distribution of site years is taken into account more precisely than was the case in the Texas study.

Those "time zones" falling within two hours driving time of the surveyed destination sites were included for analysis. The two hour cut-off for driving time encompassed nearly 95 percent of all visitors to the surveyed sites. Though this decision likely introduced a slight downward bias in consumer surplus value estimates, the bias was too small to justify the computational costs associated with going beyond the two hour limit.

A double logarithmic transformation of the data was carried out and a quantity of 1.0 was added to each of the 508 "mini" time zones to avoid a value of zero in predicting visitations (the logarithm of zero is undefined). The survey data was read off the project computer tape and entered into the SPSS multiplicative multiple regression routine.

The summary results for the multiple regression "runs" of each of the 16 surveyed sites will now be discussed. The summary outlines the impact of the independent variables (negatively or positively) within each equation, and the overall accuracy in estimating site visitations.

The multiple regression equations shown on this and the following pages lists the independent variables (after the coefficient for the constant); (1) population of time zone (X_1 in the individual site model), (2) travel time (X_2 in the individual site model), (3) average family income (X_3 in the individual site model) and (4) gravity (X_4 in the individual site model). The figures in parentheses under each of the equation coefficients are the standard errors of the estimates of the regression coefficients.

1. AUSTIN LAKE/Kalamazoo County

$$\log_{10} (Y + 1.0) = 1.16944 + .12105^* \log_{10} X_1$$

(.45175) (.04793)

$$- .52483^* \log_{10} X_2 + .75229 \log_{10} X_3 - .25842 \log_{10} X_4$$

(.066619) (.40851) (.37416)

$$R^2 = 0.34 \quad F = 21.59^*$$

$$^\dagger \text{Predicted Y value (unexpanded)} = 139$$

[†]The model estimated number of sampled visitors at the public access site.

††Observed Y value (unexpanded) = 138

*Significant at .05 level.

The regression coefficients for population and income show that as the value of these two variables increase in the time zones around Austin Lake, visitation increases. The coefficient for travel time and gravity indicate that as the values (i.e. greater travel time, greater amounts of lake acres) of these variables increase, visitations to the Austin Lake site decreases. The above observations are expected for all of the 16 surveyed sites. This equation was significant in explaining visitation at the 5 percent level of significance.

2. ORCHARD LAKE/Oakland County

$$\log_{10} (Y + 1.0) = 1.7870 + .14310 * \log_{10} X_1$$

(.38406) (.041881)

$$- 1.01622 * \log_{10} X_2 - .72310 \log_{10} X_3 + .69516 \log_{10} X_4$$

(.14252) (.71183) (.32077)

$$R^2 = 0.54 \quad F = 54.57*$$

Predicted Y value (unexpanded) = 257

Observed Y value (unexpanded) = 301

The regression coefficients for Orchard Lake show that as income values increase around Orchard Lake visitations to this site are decreased. Also, as the gravity

††The actual number of sampled visitors.

(attraction away from the surveyed site) increases, visitation increases. This could be explained in part by the popularity of the lake for boat racers. Social interaction (boat racing) could explain this variation from the expected.

3. WOLVERINE LAKE/Oakland County

$$\log_{10} (Y + 1.0) = 1.09861 + .57847* \log_{10} X_1$$

(.25720) (.022799)

$$- .50516* \log_{10} X_2 - .68762 \log_{10} X_3 - .14268 \log_{10} X_4$$

(.86846) (.40912) (.17867)

$$R^2 = .34 \quad F = 23.67*$$

Predicted Y value (unexpanded) = 149

Observed Y value (unexpanded) = 56

The only regression coefficient for Wolverine Lake that varies from the expected pattern shown at Austin Lake is that of increasing family incomes showing decreases in visitations to this site. The predicted and observed visitation figures show considerable variance for this equation.

4. SHERMAN LAKE/Kalamazoo County

$$\log_{10} (Y + 1.0) = 1.37635 + .11441* \log_{10} X_1$$

(.46952) (.037951)

$$- .68963* \log_{10} X_2 - .42796 \log_{10} X_3 - .13937 \log_{10} X_4$$

(.75804) (.37519) (.36233)

$$R^2 = 0.40 \quad F = 28.91^*$$

Predicted Y value (unexpanded) = 143

Observed Y value (unexpanded) = 105

The regression coefficients for Sherman Lake reflect expected values in relation to the explanation of site visitations.

5. LAKE FENTON/Genesee County

$$\log_{10} (Y + 1.0) = 1.65857 + .12703^* \log_{10} X_1$$

(.38474) (.030368)

$$- .89221^* \log_{10} X_2 - 1.55103^* \log_{10} X_3 - .15024 \log_{10} X_4$$

(.90419) (.37244) (.24996)

$$R^2 = 0.62 \quad F = 32.53^*$$

Predicted Y value (unexpanded) = 200

Observed Y value (unexpanded) = 242

The regression coefficient for family income varies from the expected with increases in family income showing decreases in visitation to Lake Fenton (at a significant level). The R^2 value for Lake Fenton is the highest value observed for the 16 surveyed lakes.

6. UNION LAKE/Branch County

$$\log_{10} (Y + 1.0) = .24203 + .90904 \log_{10} X_1$$

(.28342) (.26051)

$$- .74536 \log_{10} X_2 + .44816 \log_{10} X_3 - .79461 \log_{10} X_4$$

(.039882) (.28055) (.23432)

$$R^2 = 0.03 \quad F = .98$$

Predicted Y value (unexpanded) = 141

Observed Y value (unexpanded) = 17

Although the regression coefficients follow the expected pattern in explaining visitations, the R^2 value for Union Lake is extremely low. This site gets very little use during the year (lowest visitation figures of all Waterways counter sites). In the concluding section on study recommendations, the inclusion of perceived site attractiveness, fishing success, etc. will be discussed to help increase the predictive accuracy of this model for sites such as Union Lake.

7. SWAN LAKE/Montcalm County

$$\log_{10} (Y + 1.0) = .68000 + .54468* \log_{10} X_1$$

(.21329) (.19145)

$$- .33579* \log_{10} X_2 - .12217 \log_{10} X_3 - .62974 \log_{10} X_4$$

(.42177) (.15122) (.17320)

$$R^2 = 0.29 \quad F = 17.57*$$

Predicted Y value (unexpanded) = 117

Observed Y value (unexpanded) = 17

In predicting visitations to Swan Lake, the regression coefficient for income again shows as incomes increase, visitations to this particular site decrease. The overall equation is shown to be significant at the 5

percent level. The predicted Y value is considerably higher for this site, than the observed value.

8. MUSKRAT LAKE/Clinton County

$$\log_{10} (Y + 1.0) = 1.06884 + .76812* \log_{10} X_1$$

(.33026) (.23283)

$$- .45909* \log_{10} X_2 - .079735 \log_{10} X_3 - .22232 \log_{10} X_4$$

(.54289) (.19433) (.25956)

$$R^2 = 0.26 \quad F = 19.53*$$

Predicted Y value (unexpanded) = 153

Observed Y value (unexpanded) = 64

The income variable regression coefficients reflects decreased visitations as incomes increase for the Muskrat Lake site. This variable, however, does not enter the equation significantly.

9. HIGGINS LAKE/Roscommon County

$$\log_{10} (Y + 1.0) = - .084167 + .32927* \log_{10} X_1$$

(.73275) (.99276)

$$- .52559* \log_{10} X_2 + .79783 \log_{10} X_3 + 1.00301 \log_{10} X_4$$

(.16445) (.45698) (.55129)

$$R^2 = 0.34 \quad F = 11.59*$$

Predicted Y value (unexpanded) = 126

Observed Y value (unexpanded) = 238

Since Higgins Lake is considered one of the most attractive lakes in the state, it appears that gravity from other lakes does not particularly affect visitations to this site. As in previous site equations, only the population and travel time variables enter the equation significantly.

10. LAKE ST. HELEN/Roscommon
County

$$\log_{10} (X + 1.0) = 1.81630 + .48841* \log_{10} X_1$$

(.65197) (.86043)

$$- 1.10503* \log_{10} X_2 + .15475 \log_{10} X_3 + .75321 \log_{10} X_4$$

(.17003) (.47105) (.48402)

$$R^2 = 0.47 \quad F = 18.26*$$

Predicted Y value (unexpanded) = 109

Observed Y value (unexpanded) = 714

Lake St. Helen, located in Region II of the state, owes a large number of its visitations to its location in relation to the city of St. Helen. The site is located at one end of the town and is frequently used as a car "turn around" area. This explains, in part, the large variation between observed and predicted visitations.

11. CHIPPEWA LAKE/Mecosta
County

$$\log_{10} (Y + 1.0) = .80991 = .29364 \log_{10} X_1$$

(.57675) (.57863)

$$- .63870* \log_{10} X_2 + .29286 \log_{10} X_3 + .51661 \log_{10} X_4$$

(.11985) (.37381) (.43622)

$$R^2 = 0.49 \quad F = 9.54*$$

Predicted Y value (unexpanded) = 133

Observed Y value (unexpanded) = 120

Chippewa Lake is the only site that reflects a negative regression coefficient for population in explaining visitations. Gravity has a positive coefficient (non-significant) which would indicate little or no effect of this variable for this site.

12. CLEAR LAKE/Mecosta County

$$\log_{10} (Y + 1.0) = 1.6904 + .40468 \log_{10} X_1$$

(.32580) (.38336)

$$- .72555* \log_{10} X_2 + .56767* \log_{10} X_3 - .24133 \log_{10} X_4$$

(.60238) (.24348) (.26947)

$$R^2 = 0.59 \quad F = 38.55*$$

Predicted Y value (unexpanded) = 90

Observed Y value (unexpanded) = 64

Clear Lake reflects the expected pattern for regression coefficients outlined by the study sub-hypotheses. Increases in population and income reflect increases in visitations. Increases in travel time and gravity reflect a negative impact on visitations.

13. WIXOM LAKE/Gladwin
County

$$\log_{10} (Y + 1.0) = .78636 + .34095* \log_{10} X_1$$

(.80523) (.91176)

$$- .56150* \log_{10} X_2 + .32705 \log_{10} X_3 + .15573 \log_{10} X_4$$

(.15337) (.51677) (.74431)

$$R^2 = 0.30 \quad F = 9.63*$$

Predicted Y value (unexpanded) = 125

Observed Y value (unexpanded) = 187

The regression coefficient for gravity reflects little, if any influence of other water bodies related to visitations to this site. The differences in the predicted Y value reflects visitors coming from outside the two hour travel zone.

14. BIG STAR LAKE/Lake
County

$$\log_{10} (Y + 1.0) = -.10119 + .14149 \log_{10} X_1$$

(.58419) (.91353)

$$- .36688* \log_{10} X_2 + .34408 \log_{10} X_3 + .15573 \log_{10} X_4$$

(.15337) (.51677) (.74431)

$$R^2 = 0.16 \quad F = 3.99*$$

Predicted Y value (unexpanded) = 102

Observed Y value (unexpanded) = 112

Big Star Lake, one of the eight surveyed lakes in Region II of the state, shows only the travel time variable registering significant impact in explaining site

visitations. The equation is significant at the 5 percent level of significance and shows a close fit between the predicted and observed Y values.

15. WIGGINS LAKE/Gladwin County

$$\log_{10} (Y + 1.0) = .80029 + .38448* \log_{10} X_1$$

(.66457) (.074673)

$$- .62961* \log_{10} X_2 - .081092 \log_{10} X_3 + .18535 \log_{10} X_4$$

(.11079) (.40908) (.60123)

$$R^2 = 0.40 \quad F = 15.57*$$

Predicted Y value (unexpanded) = 112

Observed Y value (unexpanded) = 161

The regression coefficient for income reflects a slight negative impact on visits for this lake. Gravity is positive reflecting little effect on site visits. The overall equation is significant at the 5 percent level of significance.

16. BIG TWIN LAKE/Kalkaska County

$$\log_{10} (Y + 1.0) = .61220 + .14730 \log_{10} X_1$$

(.37963) (.84699)

$$- .46818* \log_{10} X_2 - .51731 \log_{10} X_3 + .17804 \log_{10} X_4$$

(.10183) (.36743) (.35171)

$$R^2 = 0.26 \quad F = 5.97*$$

Predicted Y value (unexpanded) = 52

Observed Y value (unexpanded) = 65

The income and gravity variables for Big Twin Lake show regression coefficients that vary from expected values. The gravity coefficient reflects little effect on visitations to surveyed site.

The importance of determining similarities in regression equations between lake sites, centers on the need to create equations for visitation prediction of non-surveyed sites and yet-to-be established public access sites. Unlike the Texas Waterplan Study that predicted visitations to man-made reservoirs of similar construction, the Michigan public access sites are on water bodies vastly different in almost all respects. Because of the differences found in Michigan public access sites both a single state-wide visitation equation and a number of regional equations were developed to take into account these site differences.

In order to create demand curves for the 16 surveyed lake sites, the expansion factors for the established visitation equations will be derived from site counter data.

Establishing Demand Curves for Surveyed Sites

After processing the data and arriving at estimators for the parameters of the model for the 16 surveyed

sites, two expansion factors were required to derive total annual visitations at each site. It should be noted that total annual visitations are required in order to develop the consumer surplus associated with each site. Since daily observations were made only 50 percent of the time the sites were open to use and since information was collected from only one member of a surveyed party, the survey data must be expanded to reflect both the number of parties entering each site during the survey period and the average size of each entering party.

The number of parties entering a site during the season was taken to be that number measured by the counters maintained by the Waterways Division at each of the surveyed sites. It was decided that counter counts, as recorded and adjusted by Waterways personnel would be used to expand visitation data rather than develop another measure of annual vehicle entry to the sites. However, the use of these figures, if later found to be in error, does not require that new information be collected from site users. An error in the counter counts does not impact the parameters of the model since these were derived without regard to the counter information. How this model is used to project use will, however, need to be adjusted if significant error is later found in counter counts. For example, if counter counts over estimate use by 20 percent, then the use projected using the model will have to be

reduced by 20 percent. This can be done by reducing the expansion factor by 20 percent or reducing the final estimate 20 percent.

In order to expand the number of surveyed vehicles to approach the Waterways Division annual counter counts for vehicles, the annual figure was divided by the surveyed vehicles figure. An example is given below:

Wolverine Lake: (example)

Waterways Vehicle Counter Total		P.A.S. Study Vehicles Interviewed		Site Vehicle Expansion Factor
4,833	÷	56	=	146

The vehicle expansion factors for the 16 surveyed sites ranged from 103 to 639. The variation between "site specific" expansion factors can be explained in part by:

- a. Small sample with respect to season.
- b. Counter counts 24 hour/day sites officially open only 16 hours/day. Only interviewed during official hours. Possible large non-daylight non-boat related use.
- c. Malfunctioning counter with non-canceling error i.e. extra counts triggered by electrical storms is greater than missed counts caused by mechanical failure.

d. Waterways records counts from May - October.

We interviewed only June - September.

e. Vehicles entering just to turn around, maintenance crews, etc. were not interviewed.

These were recorded as users by counters.

Once the total number of visitors was determined for each of the 16 surveyed sites, "site specific" demand curves were then created. This process utilized the visitation model previously discussed in detail. The first step used the data collected to quantify the unknown parameters in the model. Total visitation was developed using the expansion factors given above to provide the first point on the demand curve (i.e. use at no increase in price). In order to determine additional points on the site demand curve, travel costs were increased incrementally within the site visitation equation. As the travel costs were increased for each site, the number of visitors would decrease. (See Table 9.)

The cost figure for this study was derived by utilizing a \$0.20 per mile figure an average driving speed of 45 miles per hour.²³ The total cost to operate the car per minute was calculated at \$0.15 a minute.

In Table 9, it should be noted that once travel costs are increased to \$13.50 at Wolverine Lake there were

²³The cost per mile figure was drawn from the U.S. Congress "Travel Expense Amendments Act of 1975," Washington, D.C., March 1975.

Table 9.--Visitation Projected by Time Zone of Visitor Origin as Travel Cost Increases (Wolverine Lake) Time Zones (15 Minute Intervals).

		1	2	3	4	5	6	7	8
	\$.00	2.81	10.48	19.51	28.17	30.89	32.25	32.78	32.84
	\$.75	1.13	5.58	12.93	21.06	23.65	24.60	25.15	25.20
	\$ 1.50	.00	2.81	8.35	15.48	18.34	18.99	19.22	19.32
	\$ 2.25	.00	1.17	5.50	9.72	14.09	14.59	14.74	14.84
	\$ 3.00	.00	.50	2.66	6.36	10.39	11.18	11.28	11.34
	\$ 3.75	.00	.00	1.32	4.02	7.45	8.50	8.54	8.54
	\$ 4.50	.00	.00	.53	2.42	4.51	6.42	6.46	6.46
INCREASED	\$ 5.25	.00	.00	.22	1.15	2.70	4.63	4.80	4.80
	\$ 6.00	.00	.00	.00	.51	1.60	3.17	3.46	3.46
TRAVEL	\$ 6.75	.00	.00	.00	.17	.77	1.67	2.40	2.40
	\$ 7.50	.00	.00	.00	.06	.18	.75	1.50	1.50
COSTS	\$ 8.25	.00	.00	.00	.00	.02	.33	.93	.93
	\$ 9.00	.00	.00	.00	.00	.00	.07	.49	.67
	\$ 9.75	.00	.00	.00	.00	.00	.00	.23	.46
	\$10.50	.00	.00	.00	.00	.00	.00	.13	.28
	\$11.25	.00	.00	.00	.00	.00	.00	.00	.13
	\$12.00	.00	.00	.00	.00	.00	.00	.00	.07
	\$12.75	.00	.00	.00	.00	.00	.00	.00	.04
	\$13.50	.00	.00	.00	.00	.00	.00	.00	.00

no more predicted visitations. For the 16 sites, the point at which visitation dropped to zero ranged from \$11.25 to \$15.75 of added travel cost. Plotted demand curves for the 16 surveyed sites are included in the next section of this dissertation (Figures 6 through 21).

Estimation of Dollar Benefits for the
16 Surveyed Public Access Sites

In order to estimate the area of consumer surplus under the site specific demand curve, travel costs (given in five minute travel time increments) were multiplied by the number of predicted visitors willing to pay the surrogate charge. Table 10 given on the following page shows the predicted consumer surplus estimates for Wolverine Lake.

Added cost/estimated visitation schedules such as that presented in Table 10 were prepared for all 16 surveyed sites. (See Appendix D.) The figures (6-21) following Table 10 illustrate the site specific demand curves and the consumer surplus for each of the 16 surveyed public access sites.

Table 10.--Estimated Consumer Surplus Wolverine Lake
Site Benefit Estimation (Expanded to Annual
Visitations).

Added Cost	Estimated Number of Visitors	Consumer Surplus	Added Cost	Estimated Number of Visitors	Consumer Surplus
\$.00	14,863	\$.00	\$ 8.25	421	\$315.75
.75	11,406	8,554.50	9.00	303	227.25
1.50	8,744	6,558.00	9.75	208	156.00
2.25	6,717	5,037.75	10.50	127	95.25
3.00	5,132	3,849.00	11.25	59	44.25
3.75	3,865	2,898.75	12.00	32	24.00
4.50	2,924	2,193.00	12.75	18	13.50
5.25	2,172	1,629.00	13.50	0	.00
6.00	1,566	1,174.50	14.25	0	.00
6.75	1,086	814.50	15.00	0	.00
7.50	688	516.00	15.75	0	.00

TOTAL CONSUMER SURPLUS = \$45,249

*The consumer surplus dollar figure is equal to
\$.75 in added cost multiplied times the number of
visitors.

FIGURE 6

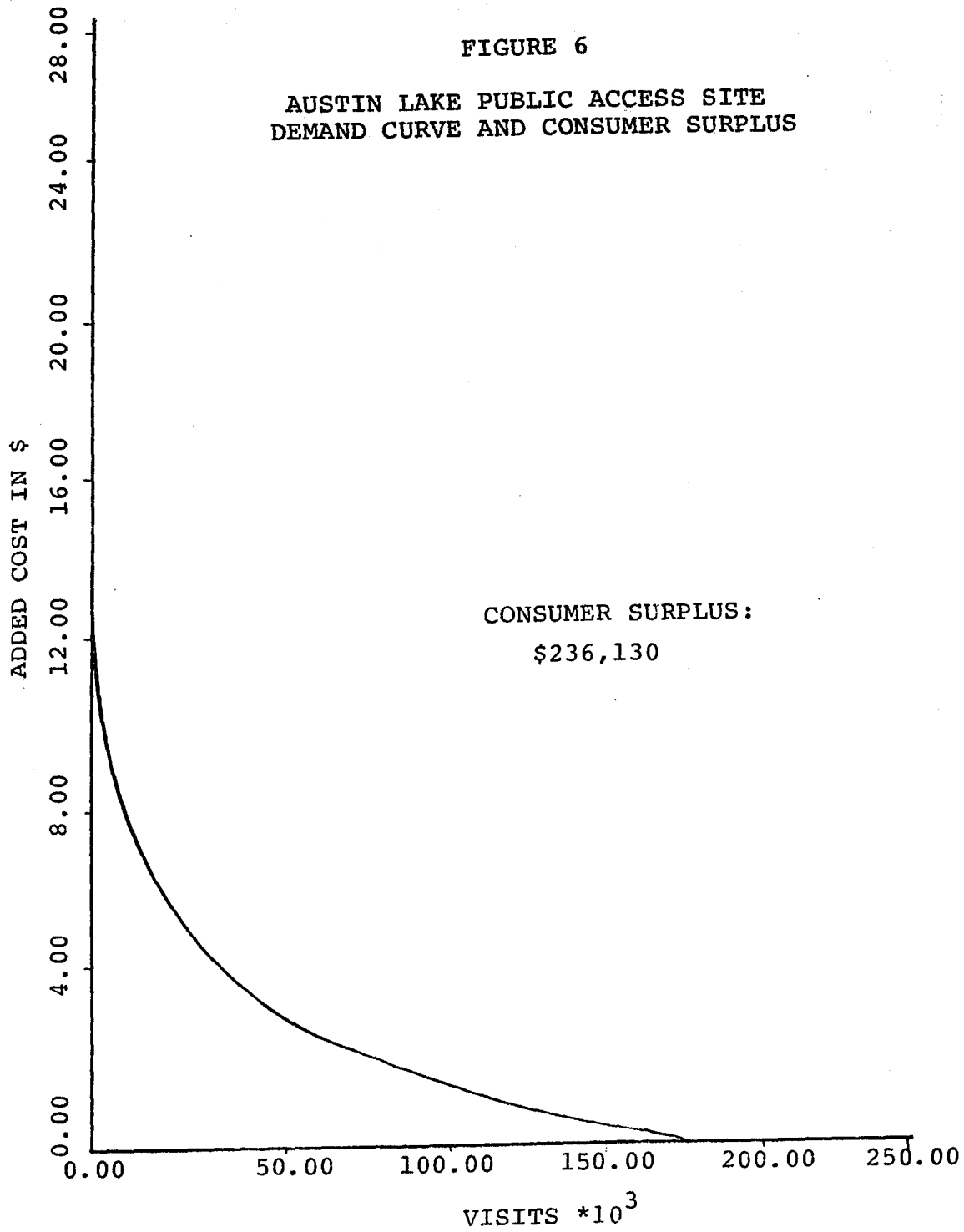
AUSTIN LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 7
ORCHARD LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

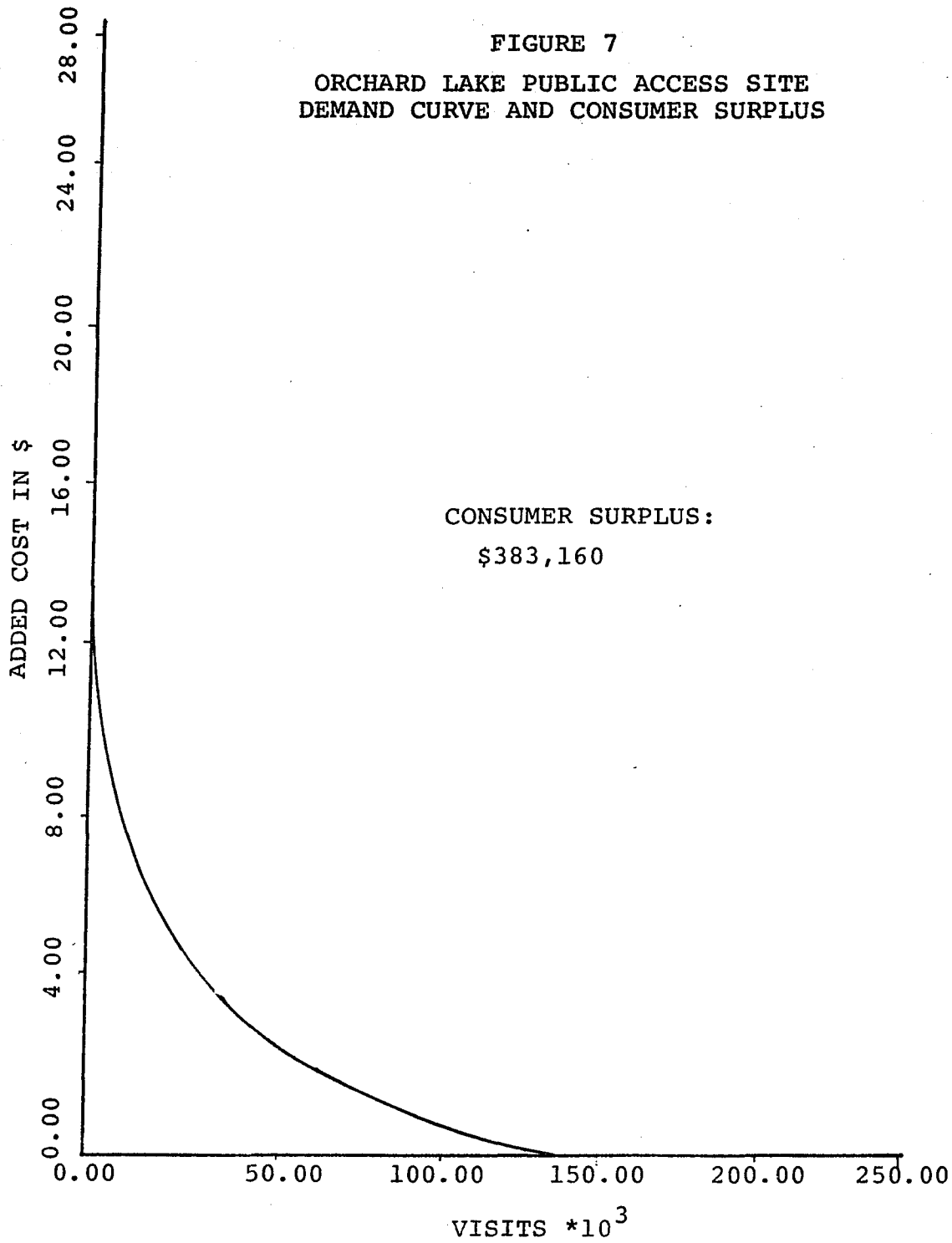


FIGURE 8

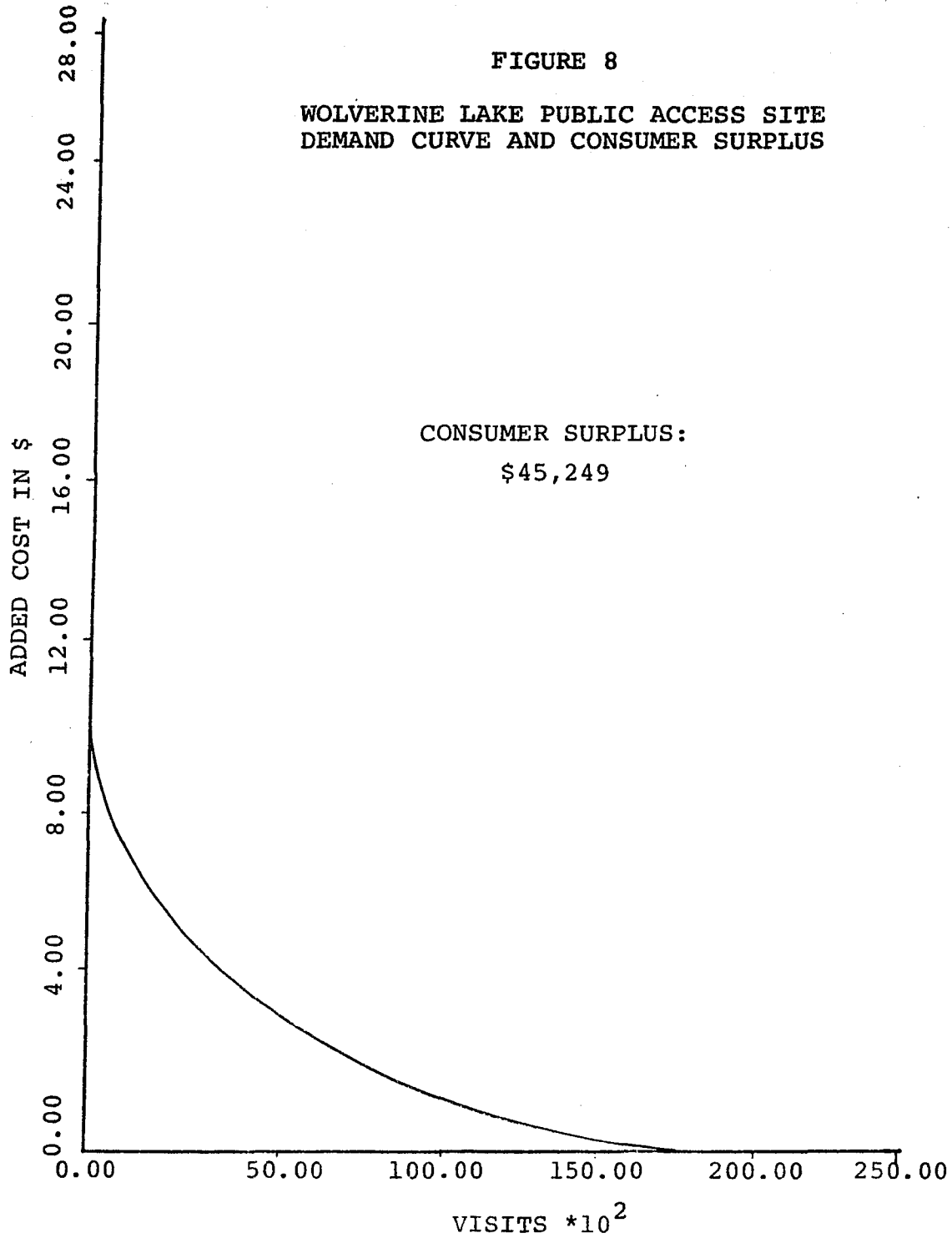
WOLVERINE LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 9

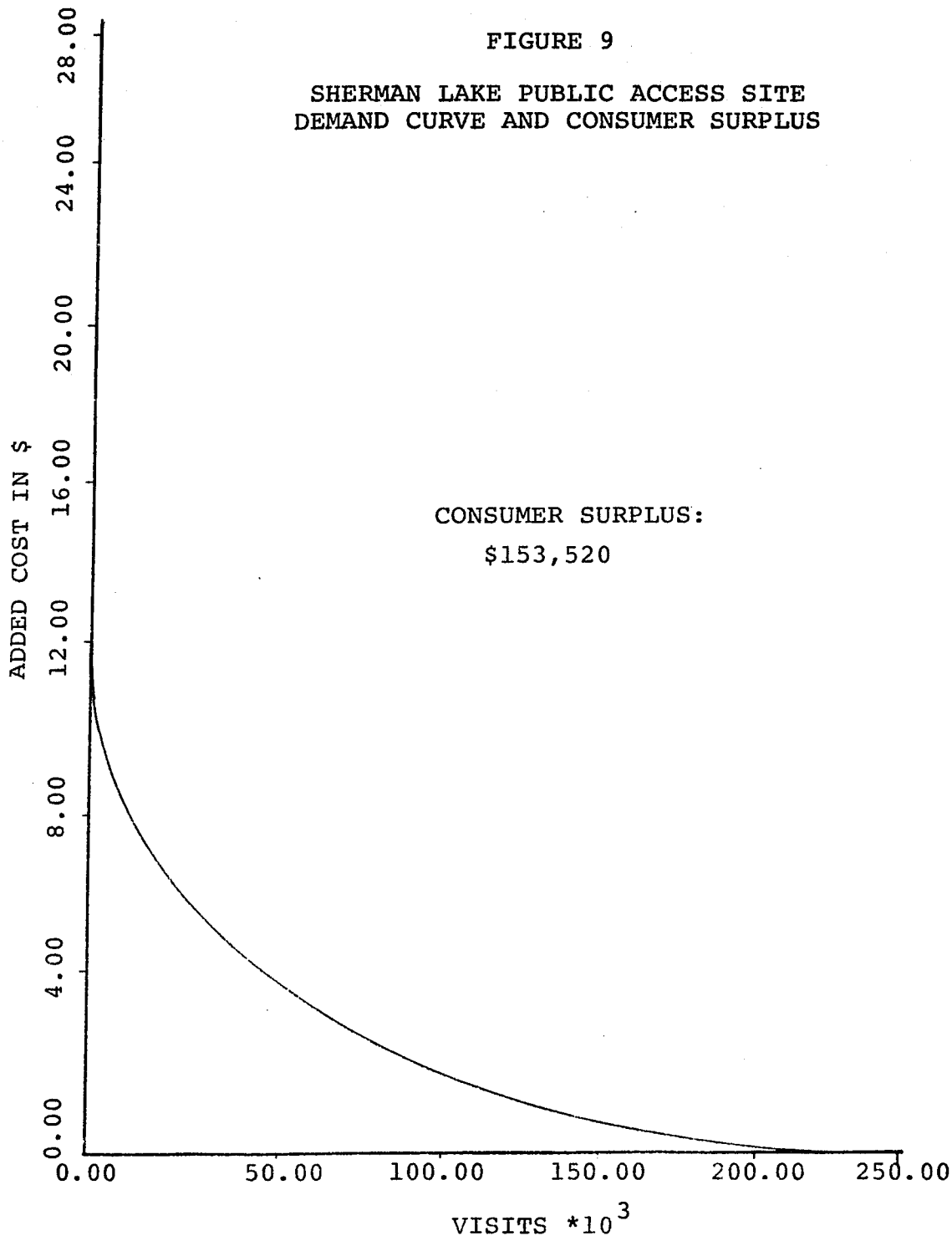
SHERMAN LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 10

PENTON LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

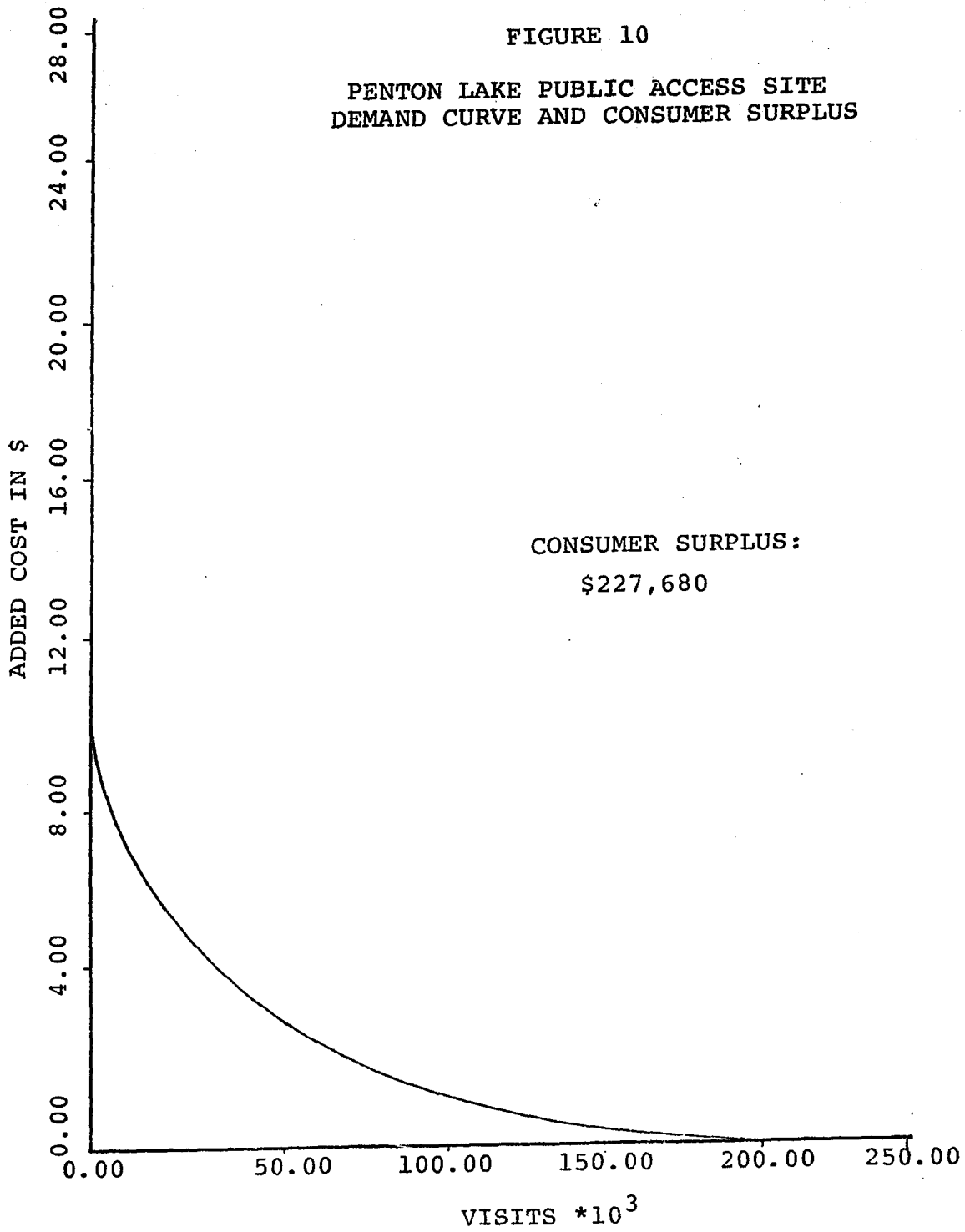


FIGURE 11

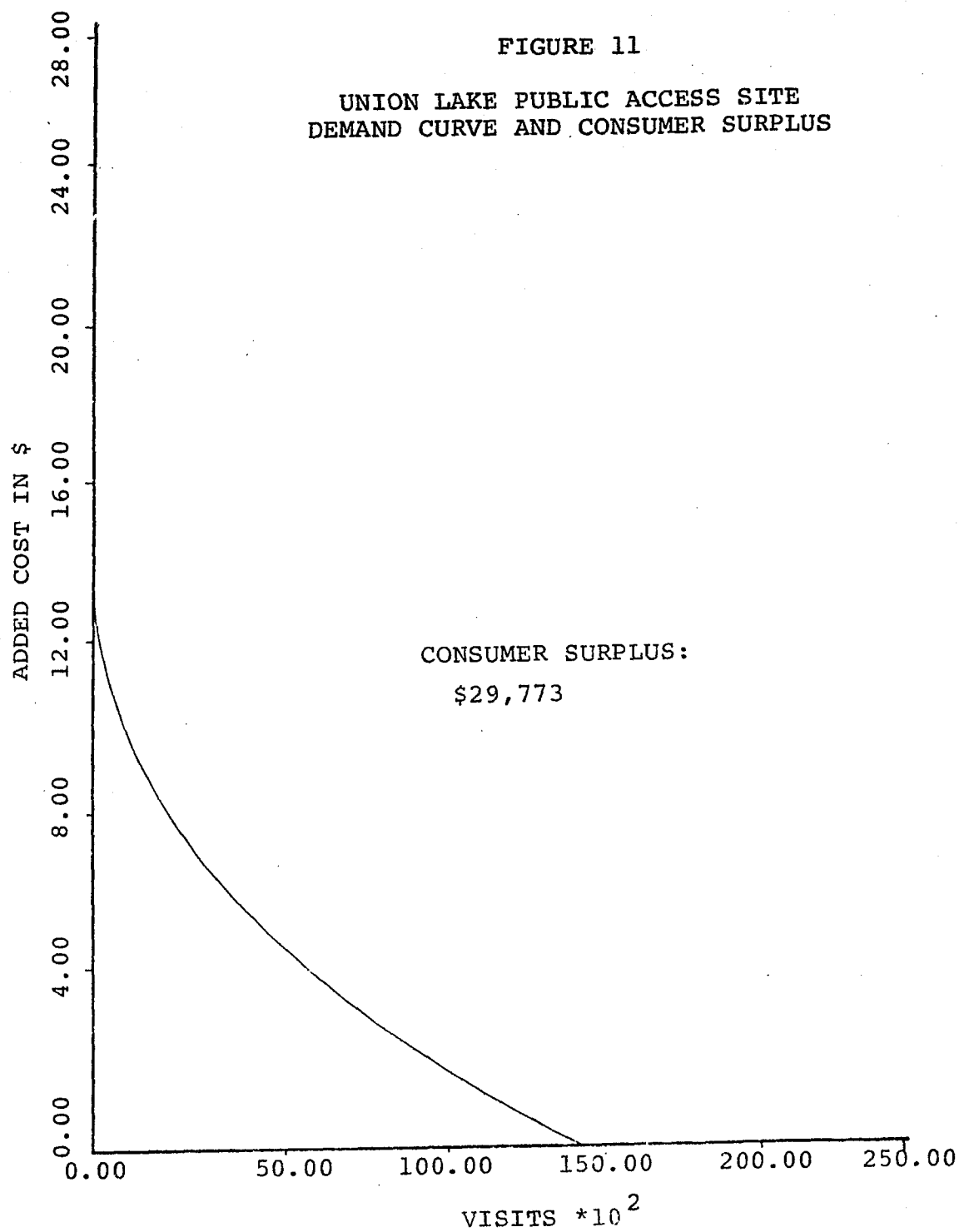
UNION LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 12
SWAN LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

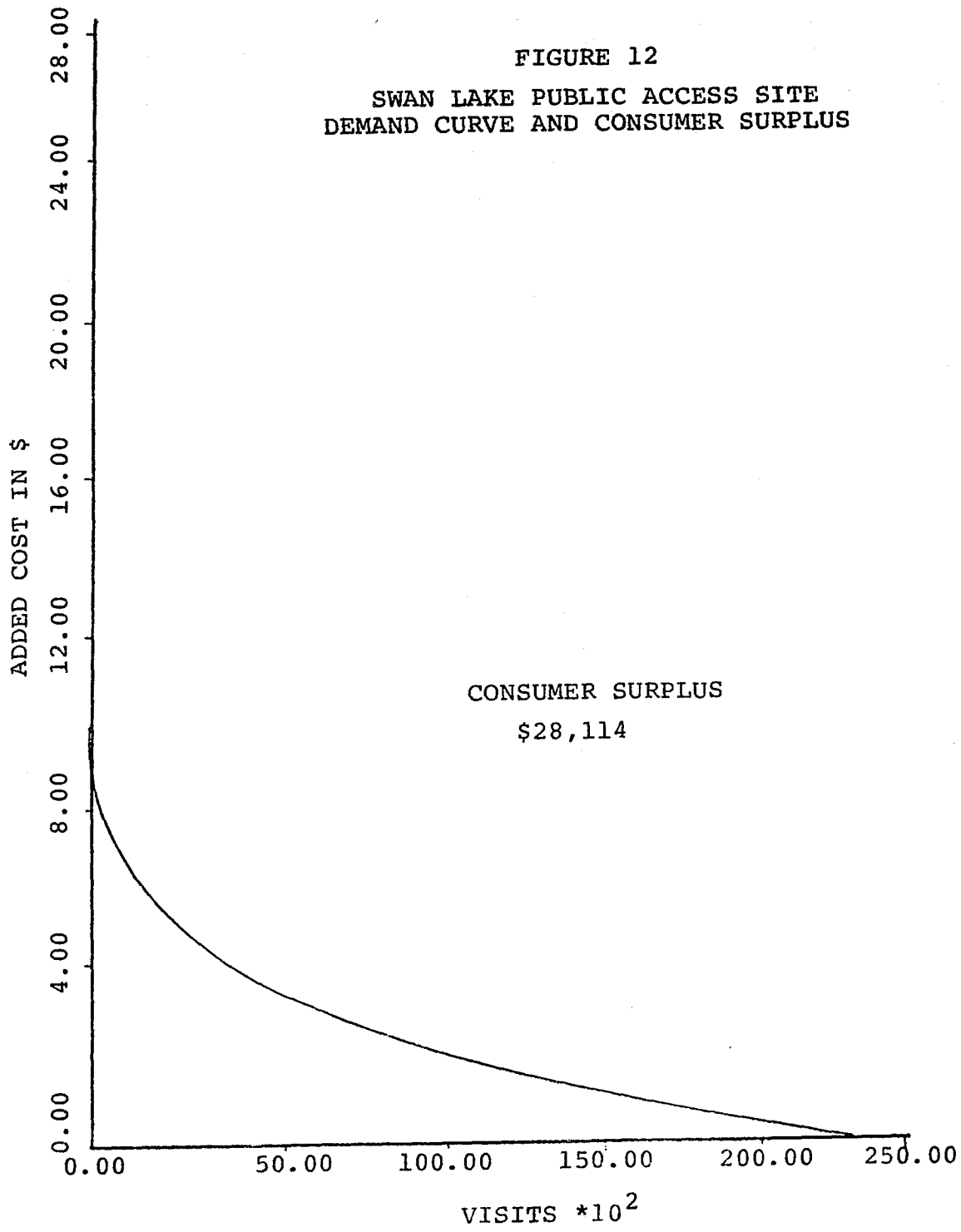


FIGURE 13

MUSKRAT LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

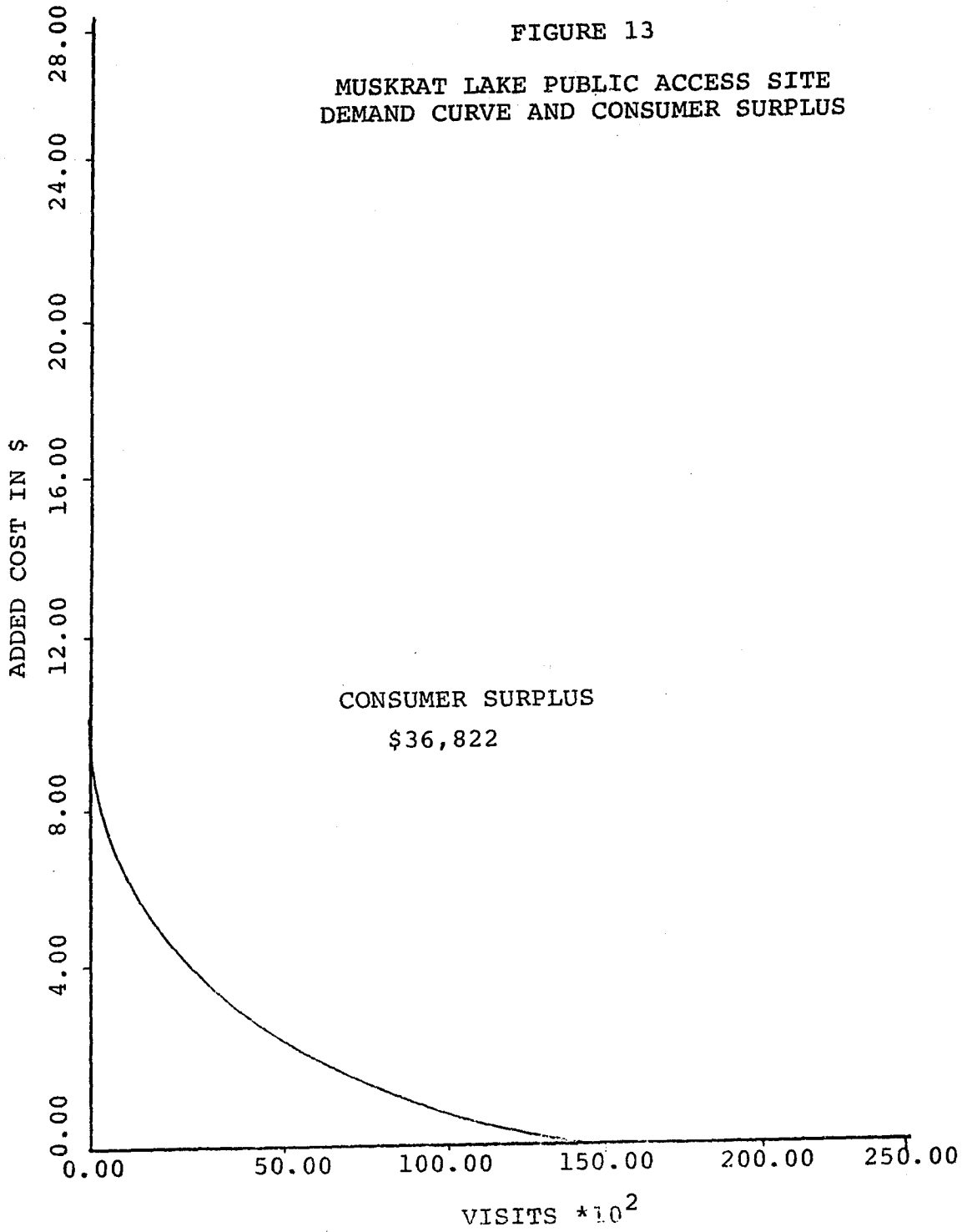


FIGURE 14
HIGGINS LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

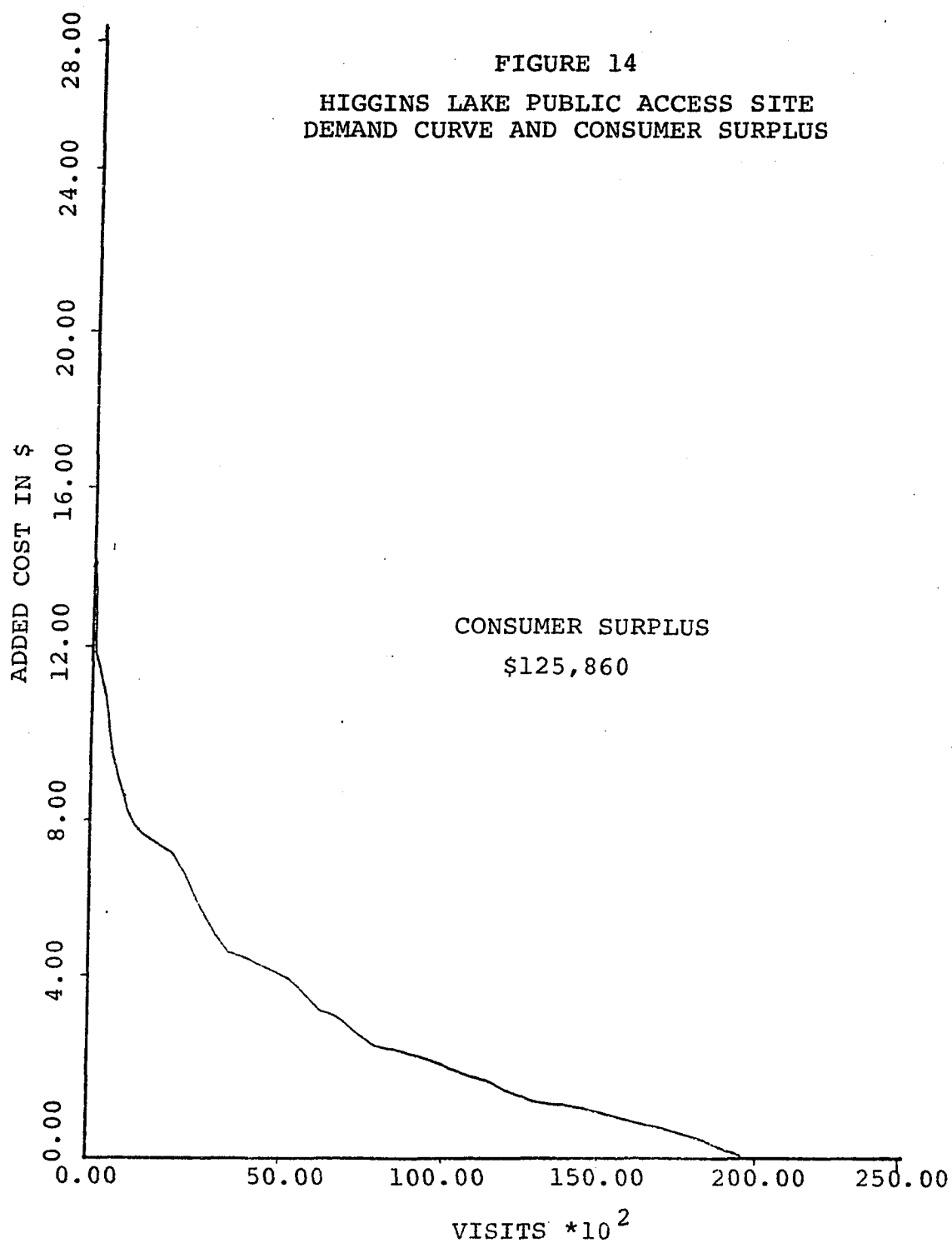


FIGURE 15
LAKE ST. HELEN PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

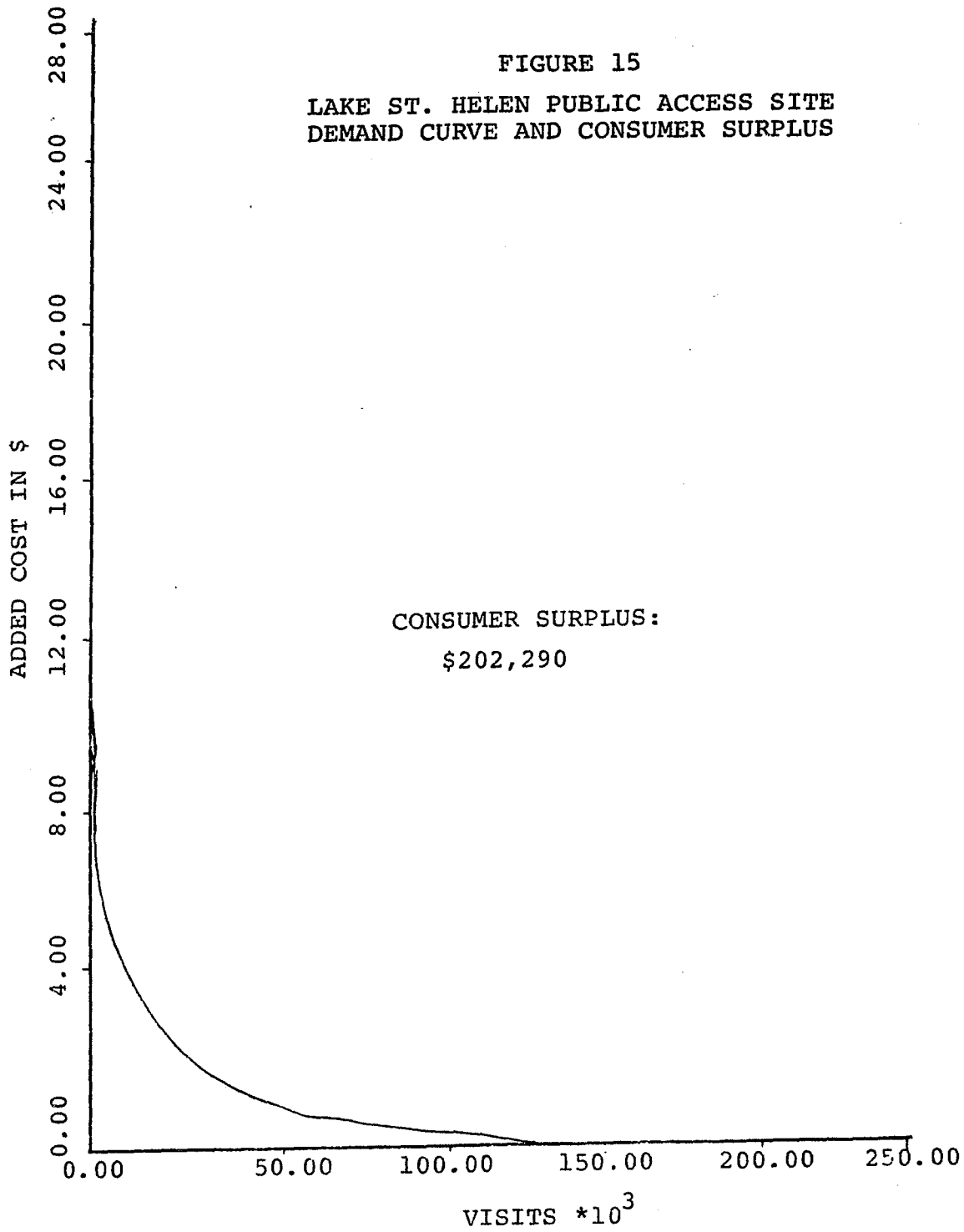


FIGURE 16
CHIPPEWA LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

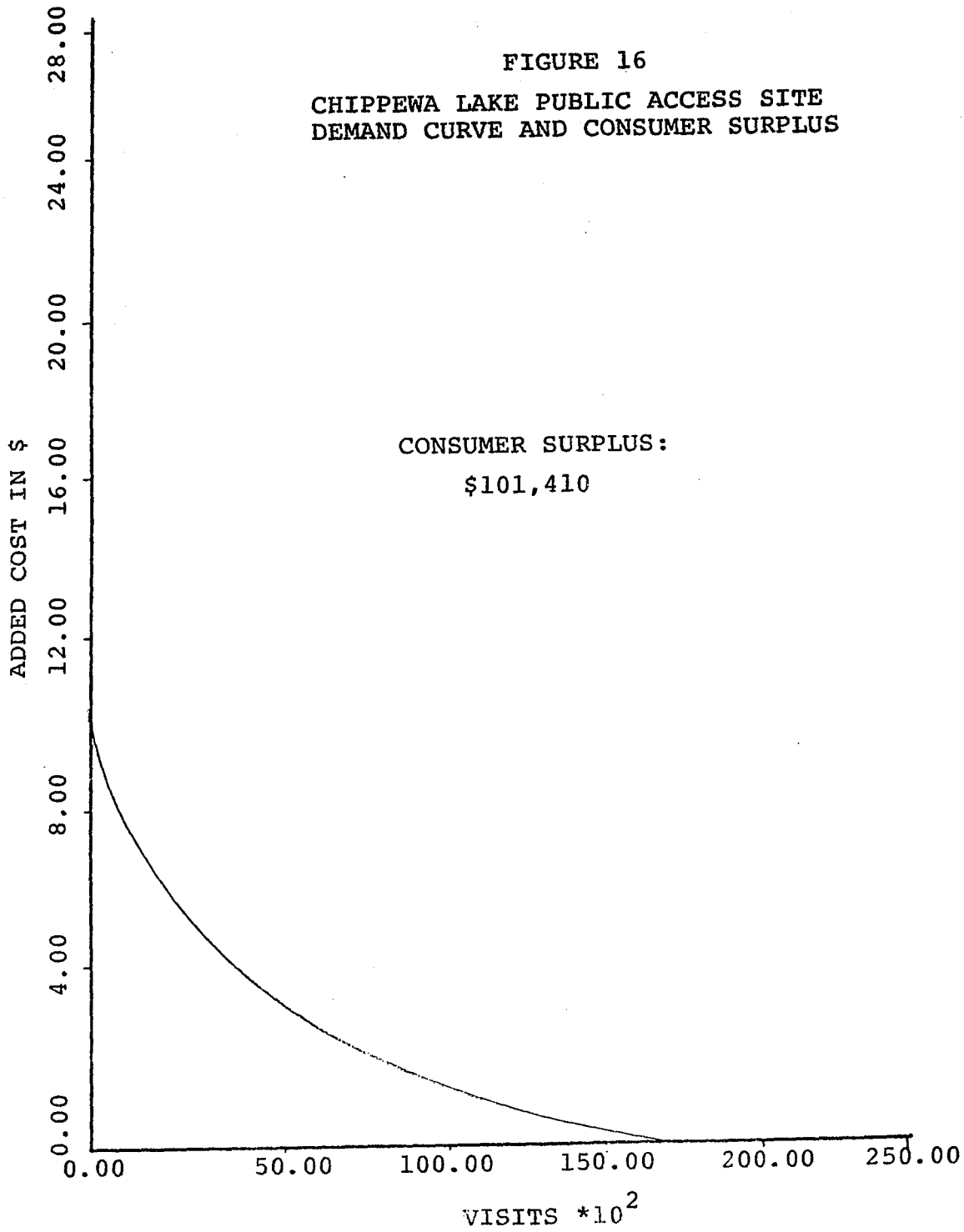


FIGURE 17

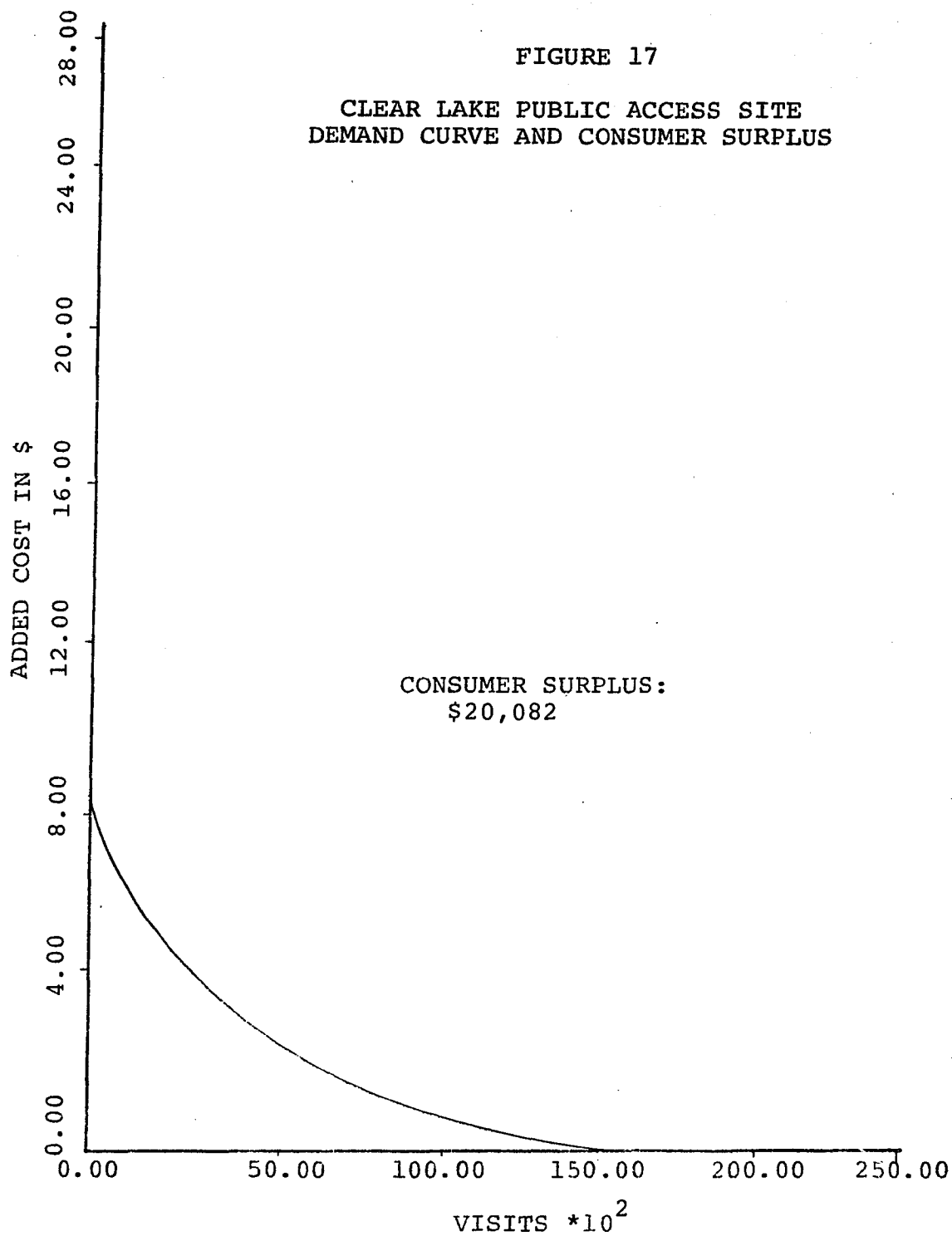
CLEAR LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 18

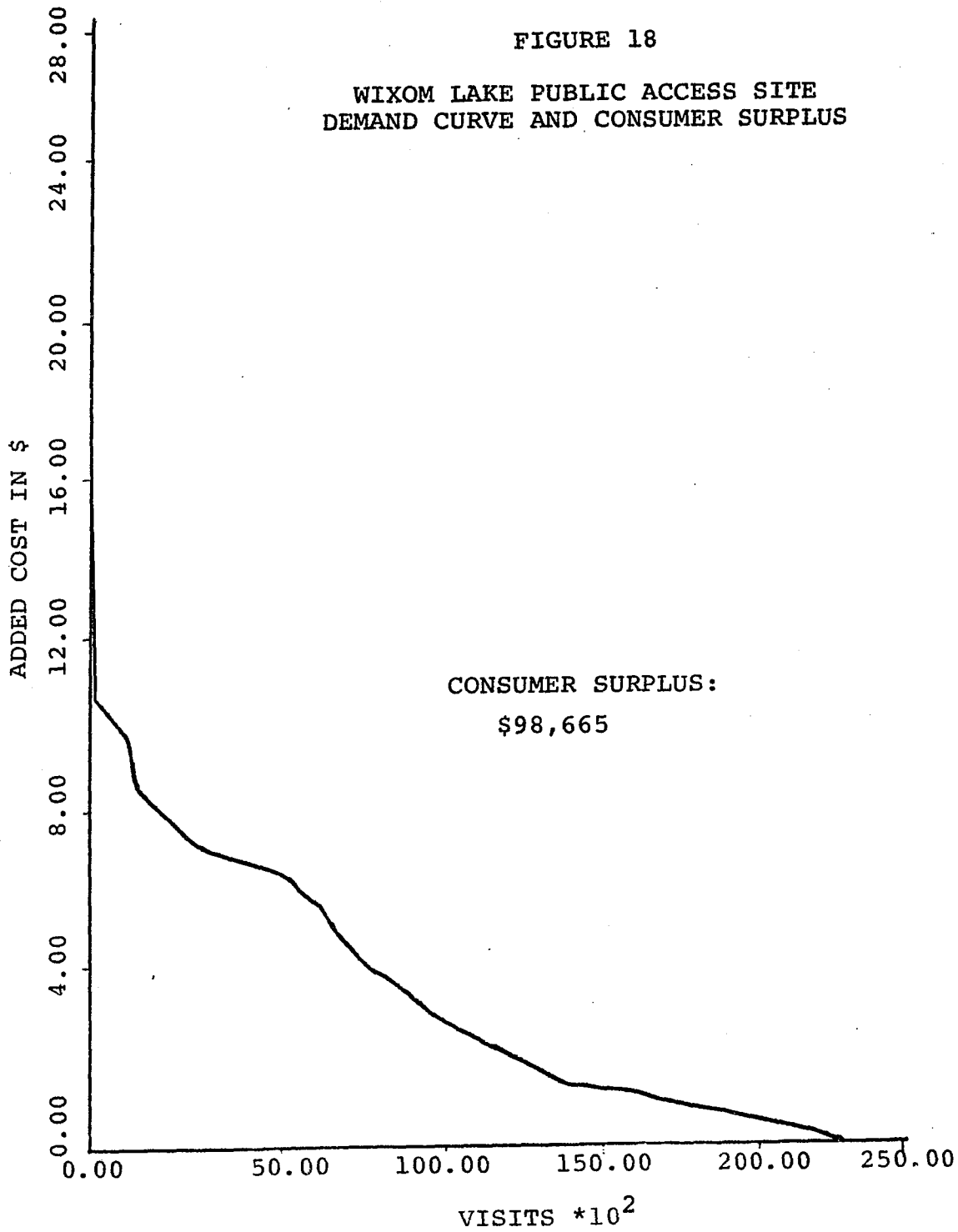
WIXOM LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

FIGURE 19

BIG STAR LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS

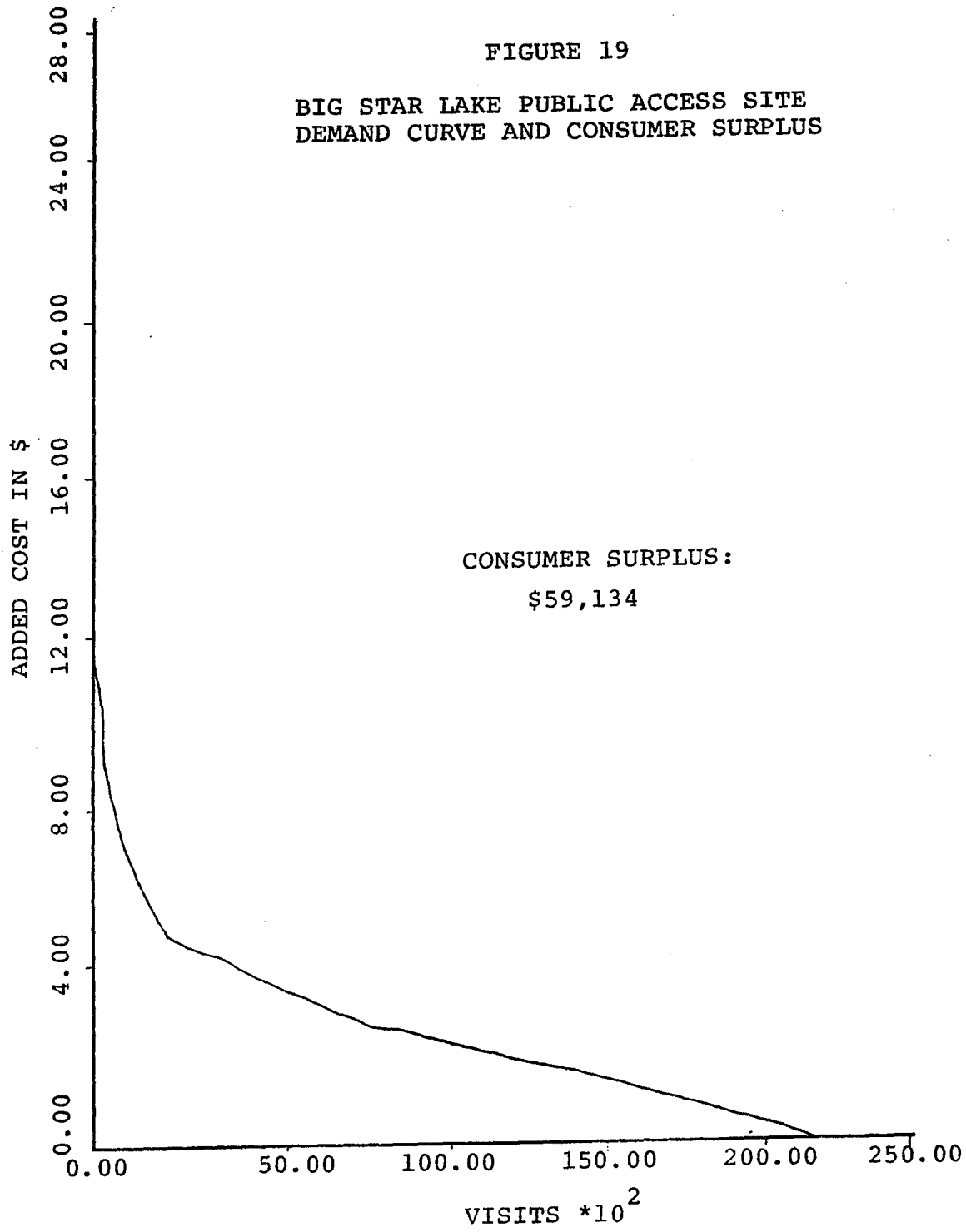


FIGURE 20

WIGGINS LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND PUBLIC SURPLUS

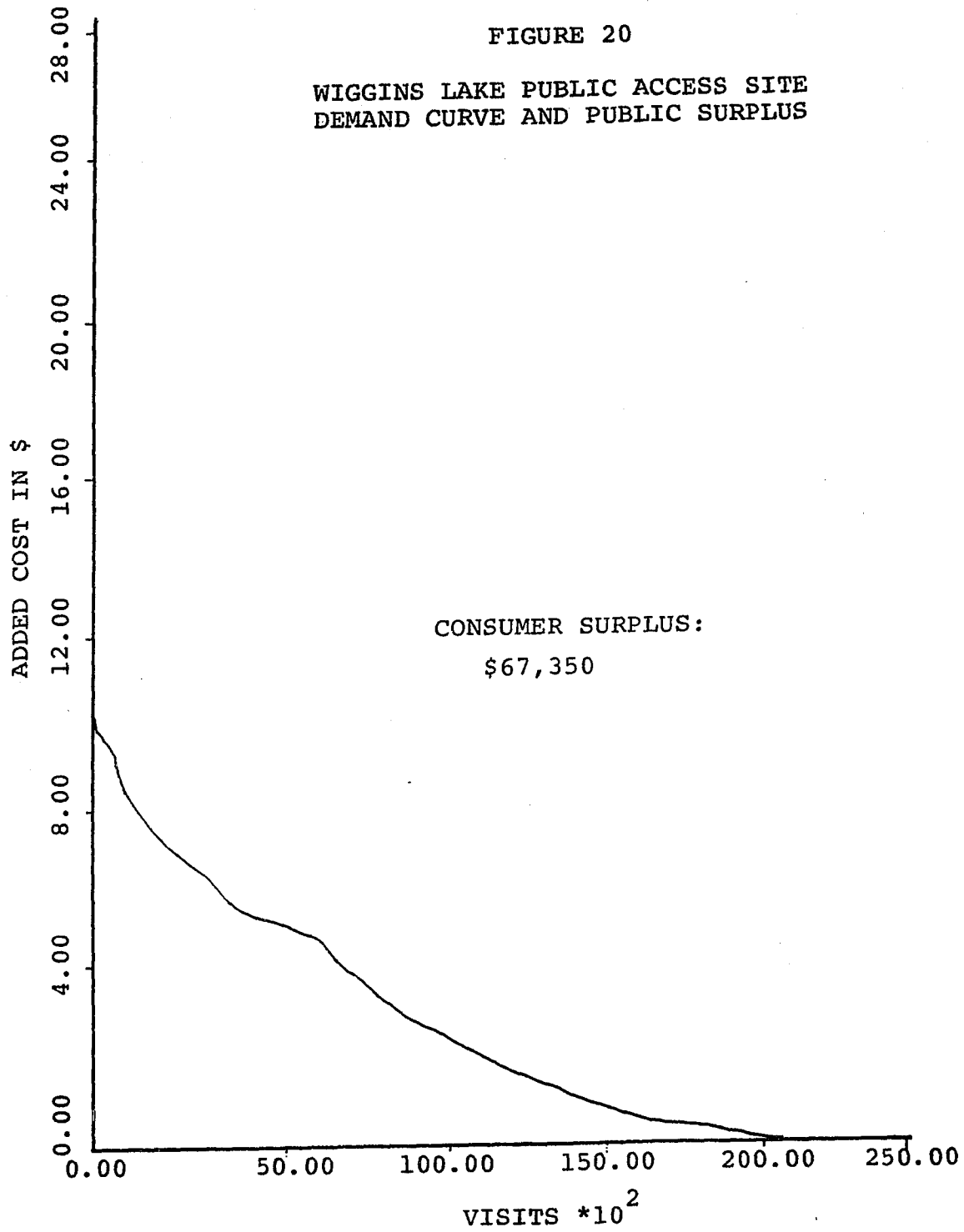
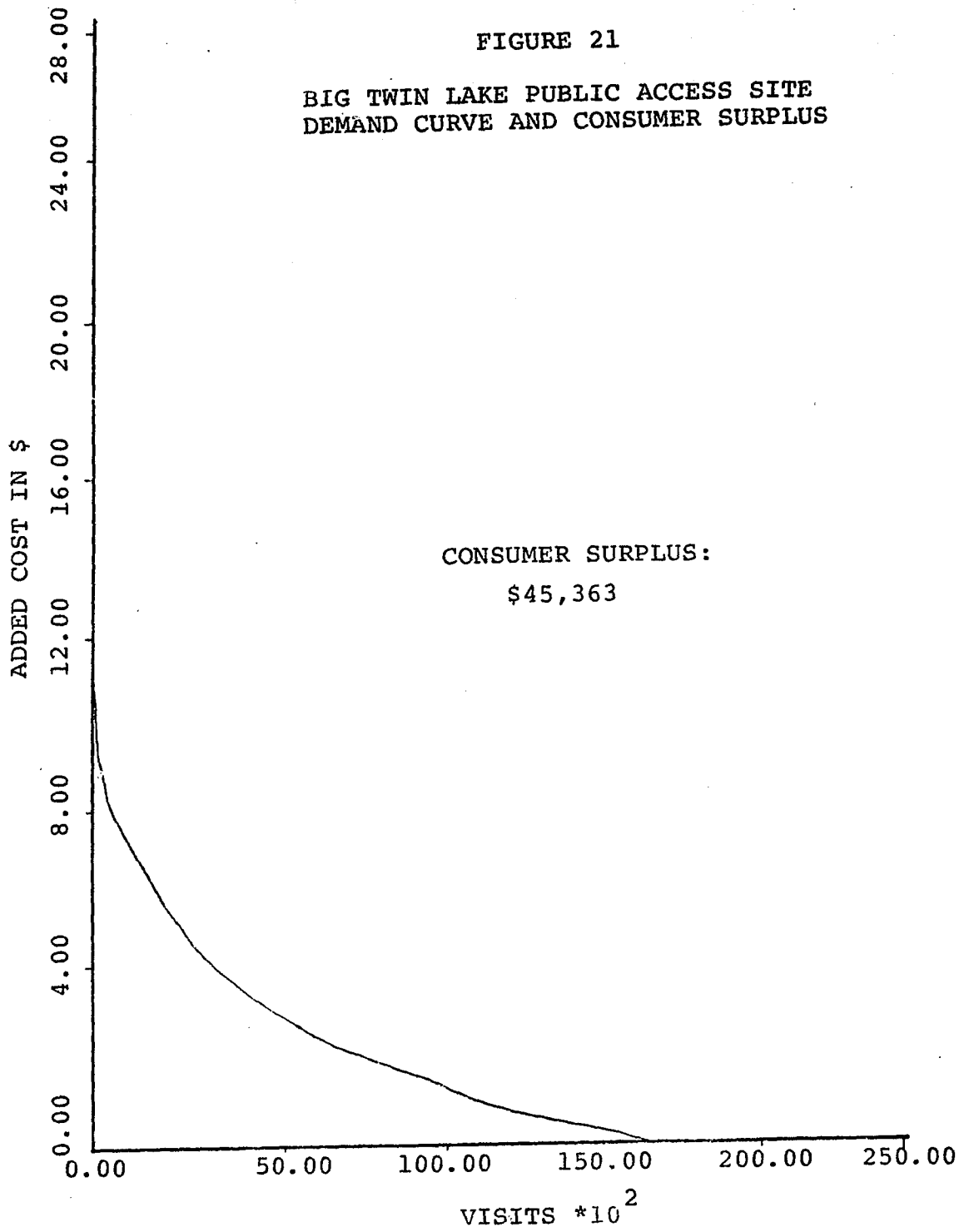


FIGURE 21

BIG TWIN LAKE PUBLIC ACCESS SITE
DEMAND CURVE AND CONSUMER SURPLUS



The breakdown for site visitations and consumer surplus is given in Table 11 on the following page. By looking at Table on the following page it can be seen that the total number of visitors entering the surveyed sites was 622,737. This figure is slightly higher than the Waterways Division counts due to the use of a passengers-per-vehicle expansion factor of 3.1 instead of 2.8 used by the Division.

The summed annual consumer surplus for the 16 surveyed sites totalled \$1,860,602. This figure suggests that each visitor would be willing to pay an average \$2.99 in travel costs to utilize the site. In other words, the visitor would be willing to travel an additional 20 miles to use a public access site on an average.

When the survey question on "how far would you be willing to travel to an alternate site of similar quality" was analysed (see Appendix B) the average willingness to travel for all 16 sites was 39 miles. This figure represents almost twice the value as shown by the visitation prediction model.

The above dollar figure is higher than the one found by Huddy in his concurrently run survey of site users on "willingness-to-pay" for the same 16 access sites.²⁴ The questions in the study survey instrument

²⁴Michael Dean Huddy, "Willingness to Pay Analysis in Public Resource Use Considerations," (Master's degree Plan B paper, Michigan State University, 1976), p. 45.

Table 11.--Estimated Annual Site Visitations and Consumer Surplus Values Summary (16 Surveyed Sites).

Lake Site	Number of Visitors	Consumer Surplus	Rank By Consumer Surplus
Orchard Lake	115,799	\$ 383,160	1
Lake St. Helen	114,129	202,290	4
Fenton Lake	83,391	227,680	3
Austin Lake	72,739	236,130	2
Sherman Lake	49,011	153,520	5
Higgins Lake	33,110	125,860	6
Chippewa Lake	29,894	101,410	7
Wixom Lake	23,451	98,665	8
Big Stan Lake	18,268	59,134	10
Wiggins Lake	18,035	67,350	9
Wolverine Lake	14,863	45,249	12
Big Twin Lake	13,802	45,363	11
Muskrat Lake	12,539	36,822	13
Swan Lake	9,515	28,114	15
Clear Lake	8,072	20,082	16
Union Lake	<u>6,119</u>	<u>29,773</u>	<u>14</u>
TOTALS	622,737	\$1,860,602	

developed by Michael Huddy asked site visitors, "how much would you be willing to pay to enter and use the public access site facility?" The Huddy survey data reflected a willingness-to-pay figure of \$1.39 per site visitor.

As discussed earlier in this dissertation under the literature review section, the willingness-to-pay approach is one way of estimating site benefits related to visits. The \$1.39 average figure for willingness-to-pay represents less than half the amount of site benefits per visitor estimated through the use of imputed demand curves. A key difference between the two approaches relates to the perceptions the visitor has toward costs of the recreational experience under willingness to pay. Under the imputed demand curve approach, travel costs incurred to reach a site are known and surrogate entrance fees are set to determine visitation patterns. However, under the willingness to pay approach, where the visitor is asked directly how much he would pay to use the site, the visitor would respond by roughly estimating the worth of the experience to him. The imputed demand curve approach to estimate recreational benefits represents a more refined method in estimation "non-market priced" benefits than the willingness to pay approach. The difference in estimates for site visitation benefits for these two studies is a large one. However, the difference is one that can be accounted for because of recognized variations in their basic research approaches.

Determination of Combined Site Visitation Equations

In the Texas Water Plan Study of 1971, once site specific visitation equations were established for surveyed sites, the data was pooled for a regression run that formed an aggregate predictive visitation equation. This model was then applied to all non-surveyed and yet to be constructed man-made reservoirs to estimate site visitations and ultimately, site benefits.

As was mentioned earlier in this dissertation, it was not known if a single model could adequately predict visitations to the numerous naturally existing lakes in the state of Michigan. This section of the dissertation discusses the combined site visitation estimation equations developed by this study. The equations are first presented and then tested for accuracy in predicting site visitations at non-surveyed sites with Waterways Division counters on them. In order to determine what model or models should be used on non-surveyed and proposed sites to project visitation at Michigan's public access sites, the following analysis was undertaken.

The Aggregated Model

The "aggregated model" was the easiest to establish for testing purposes. Since this model uses pooled data from all 16 surveyed sites to create a single site visitation equation, it could be applied to all lake

public access sites within Michigan's lower peninsula.

The single equation model shown below has added the variable for lake acreage of the destination site. This variable was added because variation was created when pooling data for multiple sites: this variation does not exist when looking at a single site. The "aggregated model" is shown below with regression coefficients and the R^2 value for the equation.

$$\log_{10} (Y + 1.0) = \begin{array}{c} \text{constant} \\ .8057 \\ (.1090) \end{array} + \begin{array}{c} \text{population} \\ .1377* \\ (.0110) \end{array} \log_{10} X_1$$

$$- \begin{array}{c} \text{travel time} \\ .8060* \\ (.0218) \end{array} \log_{10} X_2 - \begin{array}{c} \text{family income} \\ .1216 \\ (.0805) \end{array} \log_{10} X_3$$

$$- \begin{array}{c} \text{gravity} \\ .05016 \\ (.0833) \end{array} \log_{10} X_4 + \begin{array}{c} \text{lake acres} \\ .5228* \\ (.0077) \end{array} \log_{10} X_5$$

$$R^2 = .27 \quad F = 168.8*$$

* Significant at the 5 percent level of significance.

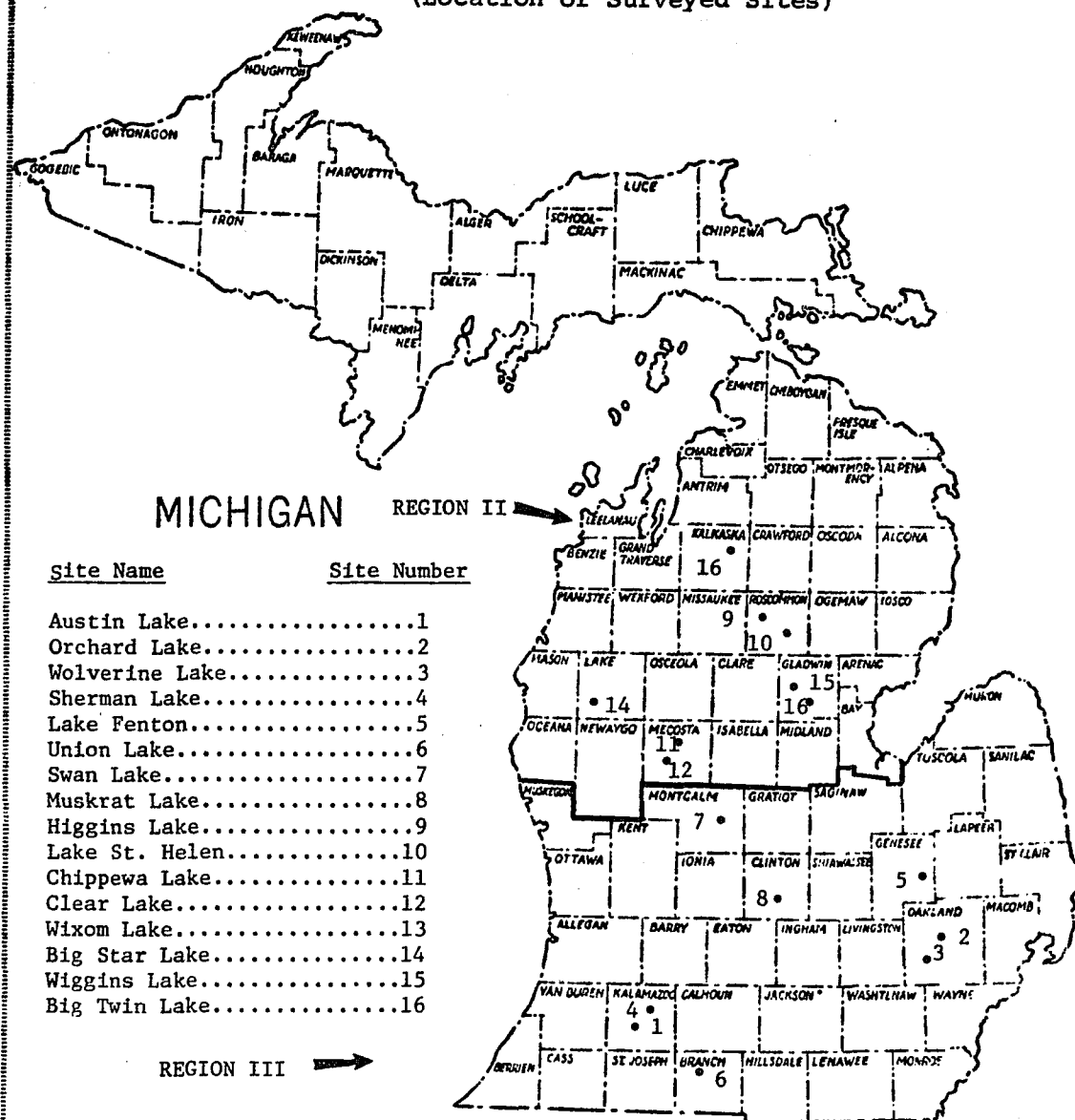
The Regional Models

(Michigan Department of Natural Resources Regions)

A second group of combined visitation equations looks at predicting visitations on a regional basis.

When looking at the state of Michigan on a regional basis, the state's lower peninsula has been divided in half between Bay City on the east and Muskegon on the west (see Figure 22).

FIGURE 22

Michigan Lower Peninsula Regions
(Location of Surveyed Sites)

This division was utilized in the study since the Waterways Division (study funding agency) is in the Michigan Department of Natural Resources and would be consistent with Departmental planning. As was indicated earlier in this dissertation, Region III is the most densely populated area of the state (8,033,600) with Region II having only 1/11th of the Region III population (729,800).

In establishing the visitation equations for each of the two regions the data from each of the eight lake site equations for each of the two regions were combined to form two separate equations. The equations are given below:

Region II Equation.--

$$\log_{10} (Y + 1.0) = \begin{array}{c} \text{constant} \\ .5841 \\ (.2113) \end{array} + \begin{array}{c} \text{population} \\ .2173* \log_{10} X_1 \\ (.0270) \end{array}$$

$$- \begin{array}{c} \text{travel time} \\ .6111* \log_{10} X_2 \\ (.0451) \end{array} + \begin{array}{c} \text{family income} \\ .1679 \log_{10} X_3 \\ (.1497) \end{array}$$

$$+ \begin{array}{c} \text{gravity} \\ .3133 \log_{10} X_4 \\ (.1686) \end{array} + \begin{array}{c} \text{lake acres} \\ .6839 \log_{10} X_5 \\ (.0141) \end{array}$$

$$R^2 = .28 \quad F = 60.4*$$

Region III equation on next page.

Region III Equation.--

$$\log_{10} (Y + 1.0) = \begin{array}{c} \text{constant} \\ 1.199 \\ (.1328) \end{array} + \begin{array}{c} \text{population} \\ .1112* \\ (.0118) \end{array} \log_{10} X_1$$

$$- \begin{array}{c} \text{travel time} \\ .6064* \\ (.0268) \end{array} \log_{10} X_2 - \begin{array}{c} \text{family income} \\ .0751 \\ (.1146) \end{array} \log_{10} X_3$$

$$- \begin{array}{c} \text{gravity} \\ .1269 \\ (.0988) \end{array} \log_{10} X_4 + \begin{array}{c} \text{lake acres} \\ .0048 \\ (.0098) \end{array} \log_{10} X_5$$

$$R^2 = .37 \quad F = 155.9*$$

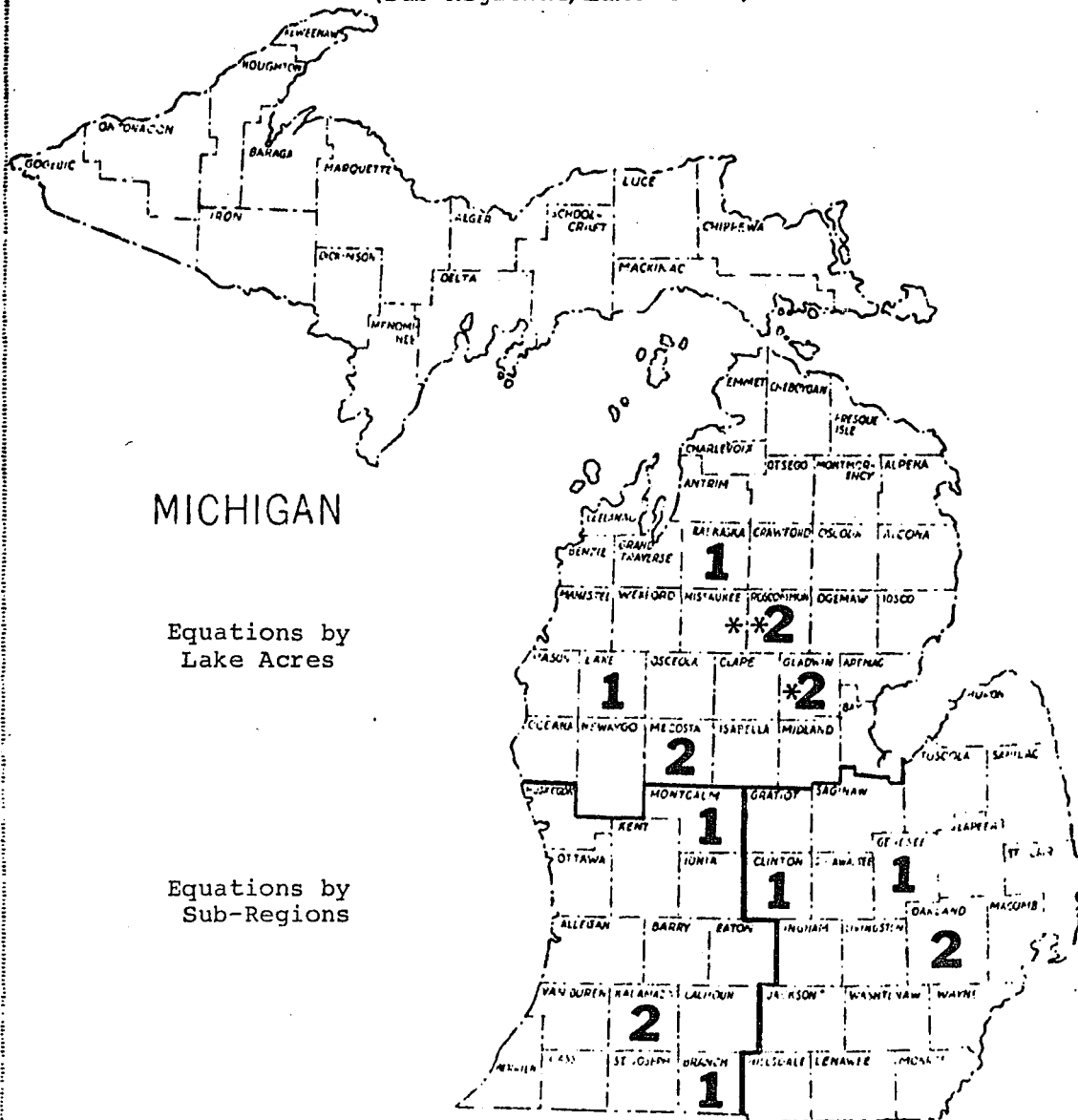
The Subregional Models

One final model breakdown combining survey site data, is tied to "sub-regional" areas for Region III and a "destination lake acres" differentiation in Region II (see Figure 23). The above breakdown was suggested by similarities in specific site equation coefficients.

It is believed that subregional population impact on public access site visitations can be used to divide up Region III of the state for model building. The reader must remember the access sites are "day use" facilities. In the eastern sub-region, Detroit and its surrounding cities influence visitations. In the western sub-region, the cities of Grand Rapids, Battle Creek and Kalamazoo would generate the greatest number of visitors. The data

Figure 23

Site Visitation Equations (Sub-Regional/Lake Acres)



*Location of 1,000 Acre Lakes

from the equations within each of these two subregions was pooled to form two visitation predicting models.

The differentiation between lake sites in Region II of the state would appear to tie most closely with lake acreage of the destination site. Region II of the state is not as densely populated as is Region III of the state. It is believed the prime attraction factor for the Region II sites is the size of the lake. The break down for Region II sites was developed for lakes over 1,000 acres and those less than 1,000 acres.

The equations developed for testing are given below:

Region III Equation - Eastern Half.--(Orchard, Wolverine, Fenton, Muskrat Lakes)

$$\begin{aligned} \log_{10} (Y + 1.0) = & \begin{array}{l} \text{constant} \\ 1.319 \\ (.1755) \end{array} + \begin{array}{l} \text{population} \\ .1147* \log_{10} X_1 \\ (.0149) \end{array} \\ & - \begin{array}{l} \text{travel time} \\ .6899* \log_{10} X_2 \\ (.0393) \end{array} - \begin{array}{l} \text{family income} \\ .5262* \log_{10} X_3 \\ (.1764) \end{array} \\ & - \begin{array}{l} \text{gravity} \\ .1058 \log_{10} X_4 \\ (.1273) \end{array} - \begin{array}{l} \text{lake acres} \\ .0170 \log_{10} X_5 \\ (.0126) \end{array} \\ R^2 = & .39 \qquad F = 103.1* \end{aligned}$$

Region III Equation - Western Half.--(Austin, Sherman, Swan Lakes).

$$\log_{10} (Y + 1.0) = \begin{array}{l} \text{constant} \\ 1.110 \\ (.2311) \end{array} + \begin{array}{l} \text{population} \\ .1024* \log_{10} X_1 \\ (.0193) \end{array}$$

$$\begin{array}{l} \text{travel time} \quad \text{family income} \\ - \quad .5456 \log_{10} X_2 + .2698 \log_{10} X_3 \\ \quad (.3697) \quad \quad (.1817) \end{array}$$

$$\begin{array}{l} \text{gravity} \quad \text{lake acres} \\ - \quad .08867 \log_{10} X_2 - .0225 \log_{10} X_5 \\ \quad (.1833) \quad \quad (.0154) \end{array}$$

$$R^2 = .34$$

$$F = 53.8^*$$

Region II Equation - 1,000 Acres Plus Destination

Lakes.--(Higgins, St. Helen, Wixom Lakes.)

$$\log_{10} (Y + 1.0) = \begin{array}{l} \text{constant} \quad \text{population} \\ .5305 \quad + \quad .3809^* \log_{10} X_1 \\ (.4397) \quad \quad (.0511) \end{array}$$

$$\begin{array}{l} \text{travel time} \quad \text{family income} \\ - \quad .7017^* \log_{10} X_2 + .09447 \log_{10} X_3 \\ \quad (.0913) \quad \quad (.2726) \end{array}$$

$$\begin{array}{l} \text{gravity} \quad \text{lake acres} \\ + \quad .4122 \log_{10} X_4 + .0695 \log_{10} X_5 \\ \quad (.3219) \quad \quad (.0488) \end{array}$$

$$R^2 = .34$$

$$F = 28.7^*$$

Region II Equation - Less Than 1,000 Acre Lakes.--

(Chippewa, Clear, Big Star, Wiggins, Big Twin Lakes.)

$$\log_{10} (Y + 1.0) = \begin{array}{l} \text{constant} \quad \text{population} \\ .5865 \quad + \quad .1268^* \log_{10} X_1 \\ (.2298) \quad \quad (.0300) \end{array}$$

$$\begin{array}{l} \text{travel time} \quad \text{family income} \\ - \quad .5622^* \log_{10} X_2 + .1397 \log_{10} X_3 \\ \quad (.0485) \quad \quad (.1708) \end{array}$$

$$+ \frac{\text{gravity}}{(.1889)} \log_{10} X_4 + \frac{\text{lake acres}}{(.0269)} \log_{10} X_3$$

$$R^2 = .26$$

$$F = 34.5^*$$

In order to test which model or model combination (all sites, regional or sub-regional/lake acres) would most accurately predict site visitations, four test sites were selected. The selected public access sites all had Waterways Division vehicle counters at their entrances which would allow a check of the predicting accuracy of the three proposed models.

The number of lake sites selected for testing was limited to sites with counters that had not been surveyed. All Region I (Upper Peninsula) sites were thrown out for testing since the study dealt with the lower peninsula sites. Also, all river, stream and Great Lakes sites with counters in Regions II and III were thrown out since the study dealt with lake sites only. Of the remaining sites available for testing purposes, the four selected sites represented a range in lake acreage, and provided testing on a geographical basis.

The sites chosen for testing the visitation estimation models were:

Lake	DNR Region	County	Acres
1. Chemung	III	Livingston	321
2. Campau	III	Kent	190
3. Houghton	II	Roscommon	19,600
4. Pratts	II	Gladwin	180

The test for the model/s was to predict estimated visitations as close to the actual site count data as possible. For each of the above test sites the initial visitation model applied, was the single "all sites" summed model. The second model applied to the test sites utilized the two "regional" equations. The third model (four equations) was broken down into geographic sub-regions for the lower half of Michigan's lower peninsula and a lake acreage breakdown for the upper half of the state as previously described. Table 12 (shown on the next page) provides the breakdown of the test results comparing counter count data to model predicted visitations.

As can be seen in Table 12, the sub-regional model provided the closest projections to actual (counter counts) use for lakes Chemung and Campau. However, the "all sites combined" model was the better predictor of combined visitations to the two lakes.

Table 12.--Visitation Models Test Results.

Lake Site	Counter Data	"All Sites" Summed Model	Regional Model	Sub-Regional Model
Lake Chemung	24,353	46,616	(III) 38,547	(E) 31,777
Lake Campau	40,621	20,322	(III) 18,293	(W) 23,273
TOTALS	64,974	66,938	56,840	55,050

Lake Site	Counter Data	"All Sites" Summed Model	Regional Model	Lake Acreage Break-Down (1000</1000>)
Houghton Lake	32,601	25,492	(II) 52,271	65,049 (1000+ acres)
Pratts Lake	13,977	14,013	(II) 39,035	32,670 (<1000 acres)
TOTALS	46,578	39,505	91,306	97,719

For Houghton and Pratts Lakes in Region II (upper half of state), the single site estimates and the total estimates for both sites had the closest fit for the "all sites-summed equation" model.

Since this study was designed both to estimate dollar benefits associated with existing public access sites and to produce a model for estimating benefits at yet to be established sites, the model must reflect the

highest possible degree of accuracy. After extensive deliberation between the members of the research team, it was decided that the "all sites" summed equation would be used in generating dollar benefits for all existing public access sites (administered by Waterways Division) in Michigan's lower peninsula. Although estimates for specific lakes could fluctuate from actual visitations, the average for all sites would most closely approximate reality.

None of the models discussed appears to be a reliable predictor for individual lake visitation at "proposed sites." Consequently, it was concluded that the models should not be used for this purpose without further refinement and/or testing. One example of a refinement that will be investigated is that of adding a site attractivity variable to the model.

Application of Combined Site Visitation
Equations to Create Demand Curves For
Existing Non-Surveyed Public Access
Sites

As was indicated in the previous section of this chapter the "all sites" summed visitation equation model was selected for use in estimating state-wide public access site benefits. In Michigan's lower peninsula, there are 339 lake public access sites. Variables for each of the non-surveyed sites (319 total) were entered into the "aggregated-all sites" model to create site

specific demand curves. The regression coefficients for the multiplicative multiple regression run were derived from the summed equation with information on the five independent variables taken from the Michigan State Highway study (Population, Travel Time, Gravity), the Waterways Division (Site Lake Acres) and the 1974 Michigan Statistical Abstract (Income).

By totalling the number of estimated visitors and generated by consumer surplus for the 319 non-surveyed sites and adding these figures to the surveyed and test sites, the state-wide figures were obtained (See Table 13) projected individual lake visitations and site benefits are given in Appendix E.

Table 13.--State-Wide Lake Public Access Site Visitations and Site Benefits (Lower Peninsula).

Number of Lake Sites	Estimated Number of Visitors	Estimated Consumer Surplus (Site Benefit)
339	5,741,774	\$20,341,473

The totalled figures for visitations represents 68 percent of the counter count annual visitations set at 8,466,390. The number of Waterways Division administrative lake public access sites in Michigan's lower peninsula represents 60 percent of all Waterways sites state-wide. It was expected that since the lakes in the lower peninsula were

closer to the large population centers, the percentage of site visitors would exceed the percentage of sites being studied.

The \$20,341,473 consumer surplus generated by the 339 lake sites represents a figure of \$3.54 in estimated benefits created by each site visitor. The individual site benefits for the largest lakes in Michigan's lower peninsula compare closely (\$200,000 annual benefit range) with those figures generated for the large reservoirs in the Texas site benefit study. It must be remembered that the \$20 million plus site benefit figure does not represent actual expenditures, but rather perceived benefits if each site could capture the total willingness to pay of each site visitor.

Application of the Study Model to Proposed
Public Access Sites in Michigan's
Lower Peninsula

As was indicated in the section of this dissertation on "Determination of Combined Site Visitation Equations" a decision was made to add at least one descriptive variable to the "all-sites/summed equation" model. It was felt that in order to eliminate predicted site visitation from gravitating to an average estimate, additional data related to site attractivity must be gathered.

The existing visitation estimation model ("all-sites" summed equation) provides an accurate average estimate for the existing sites' visitation and benefits.

However, in order to improve the accuracy of this model, a weighted site attractivity variable should be introduced into the equation. Past work on "attraction indices" has been carried out for recreation sites in Michigan. In the "RECSYS" systems analysis approach, used to generate demand estimates for recreation areas, part of the model included indices explaining the attractivity of those areas.²⁵ A review of the "RECSYS" report and other similar studies will be made in order to combine the characteristics of sites into an attractivity index applicable to this study's model. Additional information on site attractivity, once gathered, should hopefully provide the desired measure of accuracy in predicting site visitations for the yet to be constructed lake public access sites.

This topic will be covered further under the chapter on "Study Recommendations."

²⁵Michigan Department of Commerce, "A Manual for Program RECSYS," Outdoor Recreation Planning in Michigan, (Lansing, Technical Report #1, 1966), pp. 38-46.

CHAPTER V

TESTING THE STUDY HYPOTHESIS

The major hypothesis for this public access site study was stated as follows:

The monetary value of Michigan's Public Access Sites can be determined through the use of imputed demand curves.

Through the collection of data from the 16 survey sites, a model was created which predicted site visitations and computed consumer surplus for existing public access sites in Michigan.

By altering the travel cost variable (in upward increments) in the visitation model, site specific demand curves were created for all 339 lower peninsula lake sites under Waterways Division administration. Utilizing the combined site equation, the predicting model produced an R^2 of .27 with an F value of 168.80. This F value is significant at the .05 level of significance established for this study.

This study has indicated that site specific imputed demand curves can be utilized to predict benefits associated with use of Michigan's inland lake public

access sites. The acceptance of this study's model as a predictor of site visitation related dollar benefits rests in part with the acceptance of consumer surplus as a measure of dollar benefits (refer to literature review and study model sections of this dissertation). Consequently, it appears that the hypothesis has been supported by the results of this study, given the acceptance of the concept of consumer surplus. However, the final acceptance or rejection of the study hypothesis rests with the reviewer.

The Testing of Study Sub-Hypotheses

In order to test this study's six sub-hypotheses, the test results from the pooled model equation were used. By looking at the model results for all 16 study sites, the test results would reflect the impact of the independent variables on visitations for the broad spectrum of sites (related to lake acres, proximity to population centers, etc. . .). As stated earlier in this dissertation, the sub-hypotheses deal with the selected independent variables used in predicting visitations to Michigan inland lake public access sites.

Sub-Hypothesis #1

The population of the origin "time zone" will register a statistically significant positive effect on site visitations.

By looking at the test results:

Variable	β Coefficient	Standard Error- β	F	.05 Level of Signifi- cance	R ²
Origin Zone Population	.1377	.1106	154.877	Yes	.05

It is seen that the variable of population for the origin time zone fell within the required 5 percent level of significance for the F test. The contribution of 5 percent for the R² value was the second highest for the selected independent variables in explaining site visitations. The Beta coefficient is positive, indicating that as populations for time zones increase, visitations to the public access sites increase. The test results indicate that the population of origin time zones variable does contribute to the explanation of site visitations with the 5 percent level of significance. The hypothesis is accepted.

Sub-Hypothesis #2

Visitations to Michigan public access sites are negatively correlated with the Travel Cost variable.

Variable	β Coefficient	Standard Error- β	F	.05 Level of Signifi- cance	R^2
Travel Cost	-.50602	.02175	541.277	Yes	.20

The test results given above demonstrate that the Beta coefficient has a negative effect on site visitations as travel times (travel costs) increase. The results also indicate that the F test on this variable places it with the 5 percent level of significance for acceptance and the 20 percent R^2 value is the highest registered by the independent variables. The hypothesis is accepted.

Sub-Hypothesis #3

Visitation to Michigan public access sites are positively correlated with family income.

Variable	β Coefficient	Standard Error- β	F	.05 Level of Signifi- cance	R^2
Family Income	-.1216	.08051	2.2822	No	.0007

By looking at the test results, the Beta coefficient, unlike predicted results, shows that as family income levels increase visitations to public access sites decrease. The variable did not fall within the study established 5 percent level of significance.

A statement on positive or negative impact this variable has on visitations can not be made by the results of this study, since the required level of significance was not met.

Sub-Hypothesis #4

As alternate water based opportunities (gravity) increased around the origin time zone fewer visitors are expected at the destination site.

Gravity then has a negative impact on site visitations.

Referring to the test results given below,

Variable	β Coefficient	Standard Error- β	F	.05 Level of Signifi- cance	R ²
Gravity to Alternate Water Bodies	-.05016	.08335	.3621	No	.0008

the Beta coefficient indicates that as acreage and shoreline mileage for alternate water bodies increase, visitations to the study public access sites decreased. As with

the income variable, however, the gravity variable failed to fall within the accepted 5 percent level of significance.

A statement on positive or negative effect this variable has on visitations to Michigan public access sites can not be made since the variable falls outside the required level of significance for this study.

Sub-Hypothesis #5

As the lake size increases (destination site) the number of visitors will increase.

The results given below for the lake acreage variable indicator,

Variable	β Coefficient	Standard Error- β	F	.05 Level of Signifi- cance	R ²
Destina- tion Lake Acres	.05228	.00773	45.758	Yes	.01

the Beta coefficient is positive, which supports the sub-hypothesis. The variable falls within the 5 percent level of significance also supporting the sub-hypothesis. The results of this study indicate that as the acreage of a destination site increases, so do visitations. The hypothesis is accepted.

Sub-Hypothesis #6

The greater the number of parking spaces per access site, the greater the number of expected site visitations.

As indicated earlier in this dissertation, in the section on Analysis of the Data, this variable was dropped from the study visitation equation. Because the pattern of visitations to the 16 surveyed public access sites in Michigan could not be correlated to the number of site parking spaces a positive or negative test statement could not be made.

CHAPTER VI

STUDY SUMMARY

After the 16 survey sites were selected for this study, a 12 week schedule of personal interviews was carried out. Each of the 16 surveyed sites had interviewers on location a total of four days each of the three summer months of June, July and August, 1975; a total of 12 interview days per site.

At the end of the 12 week survey period, 2601 personal interviews of site visitors had been carried out. Cross-tabulation of data showed: (1) 50.7 percent of visitors brought boats to the sites (87 percent trailered), 49.3 percent did not bring boats to the site; (2) 94.1 percent of all site visitors interviewed resided within two hours driving distance of the sites; (3) average per vehicle party size was 3.1 persons, and (4) 51.6 percent of interviewed site visitors made \$15,000 or less annually.

By establishing "site specific" visitation estimation equations for the 16 surveyed sites and applying multipliers for expansion of data to annual visits (counter count data) and number of persons per vehicle, visitation predicting models were generated.

$$Y + C = A x_1^{B1} x_2^{B2} x_3^{B3} x_4^{B4}$$

where

Y = Number of annual visitors to the access site (from origin "time zone").

C = Constant used with double logarithmic transforms of the data.

X₁ = Time zone population (origin).

X₂ = Travel costs.

X₃ = Average family income.

X₄ = Gravity variable (alternative water-based recreational opportunities--around origin time zone).

Once the "site specific" model's were quantified, they were utilized to generate visitation estimates at assumed travel cost increases (i.e. site specific demand curves). The area under the demand curve (consumer surplus) then represented the dollar benefits generated by the site in relation to visitations. Table 14 shows the projected annual visits to the sites surveyed for this study along with the estimated consumer surplus associated with these visits.

Once the equations for the surveyed sites were generated, the independent variables of destination site lake acreage was added to the model. The data from the 16 sites was then pooled creating a single multiple regression equation for the study model. The resultant single "summed" equation, after being tested and compared with other possible combinations, was selected for use in

Table 14.--Estimated Site Visitations and Consumer Surplus.

Lake Site	Number of Visits	Consumer Surplus
Orchard Lake	115,799	\$ 383,160
Lake St. Helen	114,129	202,290
Fenton Lake	83,391	227,680
Austin Lake	72,739	236,130
Sherman Lake	49,011	153,520
Higgins Lake	33,110	125,860
Chippewa Lake	29,894	101,410
Wixom Lake	23,451	98,665
Big Star Lake	18,268	59,134
Wiggins Lake	18,035	67,350
Wolverine Lake	14,863	45,249
Big Twin Lake	13,802	45,363
Muskrat Lake	12,539	36,822
Swan Lake	9,515	28,114
Clear Lake	8,072	20,082
Union Lake	6,119	29,773
TOTALS	622,737	\$1,860,602

predicting visitations and consumer surplus for all 339 existing lake public access sites in Michigan's lower peninsula.

The visitation and consumer surplus totals for all 339 sites are given below.

Table 15.--State-Wide Lake Public Access Site Visitations and Site Benefits.

Number of Lake Sites	Estimated Number of Visitors	Estimated Consumer Surplus
339	3,741,744	\$20,341,473

After completing site visitation predictions and benefit estimations for existing sites, the model was then reviewed for its usefulness in selecting new sites for inclusion in the access site system. Since the "summed" equation model established averages over a wide range of different types of sites for visitations to a site, it was determined that additional work on a site attractivity variable would be conducted. It is hoped that by adding an attractivity variable to the site visitation equation, predicting accuracy will be improved to the point that visits to proposed sites can be adequately determined.

CHAPTER VII

STUDY RECOMMENDATIONS

After reviewing the various phases of this study, a number of recommendations can be made to improve the model building procedure and the visitation estimation model itself.

Under the section on "Research Methods" several suggestions for improvement can be made. Because of the variety in the characteristics (natural and man-made) of the Michigan public access sites, a classification system for sites should be developed prior to the selection of sites to be surveyed. The classification of existing sites by extent of site development, natural attractiveness, water quality, etc... should be made to allow adequate sampling of the range of site types. By establishing a site classification system, newly proposed sites could be categorized by personnel in the field, and the site visitation equation developed for that class of site could be inputted into the computer to estimate accurately, visitations and related site benefits.

The success in gathering data from the site visitor, for this study, hinged on the design and

utilization of the survey instrument. For this type of study, the short personal interview provided immediate response from the site visitor and allowed additional substudies related to site use to be carried out at no added cost to the granting agency. As far as the number of sites surveyed is concerned, re-evaluation of the sample population should be made once a clearcut site classification system is established.

A follow-up to this lake study should look at the visitation patterns for Great Lakes, rivers and streams and Upper Peninsula public access sites to predict use and determine the total benefits related to the Waterways Division public access site system. Since model building procedures for Michigan have been developed, adaptation to non-lake sites could be carried out with improved efficiency in data gathering and analysis.

Under the "Analysis" section of this study, the variable dealing with "site attractiveness" is thought to be a key in determining why lakes within equal driving distance from major population centers show marked differences in annual visitations. At the time of this writing, the components of an "attractiveness" variable have yet to be defined. However, the parameters of this variable will be established, with the variable then added to the visitation model. Additional independent variables could be looked at in an attempt to improve the predictive

accuracy of this studys' model. However high levels of data aggregation for variables (shown in similar visitation estimation studies) should be avoided.

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APPENDICES

APPENDIX A

WATERWAYS DIVISION PUBLIC ACCESS
"SAMPLED SITES"

WATERWAYS DIVISION
PUBLIC ACCESS SITE STUDY
(1975-1976)

"Sample Sites"
(Summer 1975)

I. High Population/High Lake Acreage (Measure of
Alternate Opportunities)

1. Austin Lake	Kalamazoo Co.	1050 Acres	47 Parking
2. Orchard Lake	Oakland Co.	788 Acres	63 Parking
3. Wolverine Lake	Oakland Co.	241 Acres	15 Parking
4. Sherman Lake	Kalamazoo Co.	120 Acres	36 Parking

II. High Population/Low Acreage

1. Lake Fenton	Genesee Co.	845 Acres	15 Parking
2. Union Lake	Branch Co.	518 Acres	5 Parking
3. Swan Lake	Moncalm Co.	127 Acres	25 Parking
4. Muskrat Lake	Clinton Co.	39 Acres	40 Parking

III. Low Population/High Lake Acreage

1. Higgins Lake	Roscommon Co.	9900 Acres	50 Parking
2. Lake St. Helen	Roscommon Co.	2400 Acres	15 Parking
3. Chippewa Lake	Mecosta Co.	770 Acres	30 Parking
4. Clear Lake	Mocosta Co.	130 Acres	5 Parking

IV. Low Population/Low Lake Acreage

1. Wixon Lake	Gladwin Co.	1980 Acres	60 Parking
2. Big Star Lake	Lake Co.	912 Acres	80 Parking
3. Wiggins Lake	Gladwin Co.	345 Acres	15 Parking
4. Big Twin Lake	Kalkaska Co.	215 Acres	5 Parking

APPENDIX B

STUDY SURVEY INSTRUMENT

Recreation Research & Planning
Unit Study
Michigan State University

MICHIGAN
PUBLIC ACCESS SITES

Site Visitation Information

NOTE: Please check a single response to each of the five questions below.
(Your response remains completely anonymous according to strict
University research codes.)

I. Primary use of the site: (Check one)

- | | |
|---------------------------|----------------------------|
| 1. Pleasure boating _____ | 6. Scuba/Skin Diving _____ |
| 2. Fishing _____ | 7. Sun Bathing _____ |
| 3. Hunting _____ | 8. Picnic _____ |
| 4. Swimming _____ | 9. Other _____ |
| 5. Skiing _____ | |

II. Number of people in your immediate family: (Check one)

- | | | |
|---------|---------|------------------|
| 1 _____ | 4 _____ | 7 _____ |
| 2 _____ | 5 _____ | 8 _____ |
| 3 _____ | 6 _____ | 9 and over _____ |

III. Education level of the head of household: (Check one)

1. Elementary school _____
2. Junior high _____
3. Some high school _____
4. High school _____
5. Some college (includes associate degree) _____
6. BS/BA _____
7. MS/MA _____
8. MD/DDS _____
9. PhD _____

IV. Annual family income/before taxes: (Check one)

- | | |
|----------------------------|-------------------------|
| 1. Less than \$5,000 _____ | 7. 30,001-35,000 _____ |
| 2. 5,000-10,000 _____ | 8. 35,001-40,000 _____ |
| 3. 10,001-15,000 _____ | 9. 40,001-45,000 _____ |
| 4. 15,001-20,000 _____ | 10. 45,001-50,000 _____ |
| 5. 20,001-25,000 _____ | 11. Over 50,000 _____ |
| 6. 25,001-30,000 _____ | |

V. If this access site was not available for use, how many miles would you
be willing to travel to utilize a site of similar quality? _____ (Write
in number of miles)

THANKS FOR YOUR COOPERATION!! THIS INFORMATION WILL HELP THE MICHIGAN STATE
WATERWAYS COMMISSION PLAN FOR BETTER PUBLIC ACCESS SITES THROUGHOUT THE STATE.

**MICHIGAN
PUBLIC ACCESS SITES**

Site Visitation Information

Date: / / 1975
Mo. Day Year

Site No.

Day: M T W TH F S S

Respondent No.

(circle one)

Weather Conditions: (Check one)

Sunny
Partly Cloudy
Cloudy
Raining

Time of Interview: (Check one)

AM 6:00 - 7:00 <u> </u>	11:01 - 12:00 <u> </u>	4:01 - 5:00 <u> </u>
7:01 - 8:00 <u> </u>	PM 12:01 - 1:00 <u> </u>	5:01 - 6:00 <u> </u>
8:01 - 9:00 <u> </u>	1:01 - 2:00 <u> </u>	6:01 - 7:00 <u> </u>
9:01 - 10:00 <u> </u>	2:01 - 3:00 <u> </u>	7:01 - 8:00 <u> </u>
10:01 - 11:00 <u> </u>	3:01 - 4:00 <u> </u>	

Did this group of individuals bring a boat to the site:

 *yes no

*If yes: trailered car top

Number in party:

City of Residence: County State

Distance traveled to the PAS: miles

Travel time: Hrs. Min.

Do you currently reside on a lake yes no.

APPENDIX C

SURVEY DAILY TABULATION SHEET
(BOATS TO SITE/COUNTER CHECK)

DAILY INFORMATION SHEETDate: / / Site Number:

Day: M T W T H F S S

Time Shift: AM / PM
(Circle one)

Counter count:

Enter site
Leave site Number of vehicles bringing boats onto the site: (mark -
~~111~~ for initial count)End of time shift - total vehicle/boat count:

APPENDIX D

CROSS TABULATION OF SURVEY INFORMATION
FOR THE 16 SURVEY SITES

TABLE A1
 Cross Tabulation For 16 Survey Sites
 Number and Percentage of Interviews By Day of Week

LAKE	COUNT	MONDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	ROW TOTAL
	PCT						
		1	4	5	6	7	
AUSTIN	1	10	5	15	52	55	138
		7.2	3.6	11.6	37.7	39.9	5.3
		4.1	2.2	2.4	7.6	7.2	
		.4	.2	.5	2.0	2.1	
ORCHAR	2	33	58	76	70	64	301
		11.0	19.3	25.2	23.3	21.3	11.6
		13.7	25.2	11.3	10.2	8.3	
		1.3	2.2	2.9	2.7	2.5	
WOLVERINE	3	8	3	15	14	23	56
		10.7	5.4	17.9	25.0	41.1	2.2
		2.5	1.3	1.5	2.0	3.0	
		.2	.1	.4	.5	.9	
SHERMAN	4	12	22	23	24	24	105
		11.4	21.0	21.9	22.9	22.9	4.0
		5.0	9.6	3.4	3.5	3.1	
		.5	.8	.9	.9	.9	
FENTON	5	28	7	43	68	96	242
		11.6	2.9	17.8	28.1	39.7	9.3
		11.6	3.0	6.4	9.9	12.5	
		1.1	.3	1.7	2.6	3.7	
UNION	6	3	6	4	3	7	17
		17.6	0	23.5	17.6	41.2	.7
		1.2	0	.6	.4	.9	
		.1	0	.2	.1	.3	
SWAN	7	1	2	4	8	2	17
		5.9	11.8	23.5	47.1	11.8	.7
		.4	.9	.6	1.2	.3	
		.0	.1	.2	.3	.1	
MUSKRAT	8	6	1	7	15	35	64
		9.4	1.6	10.9	23.4	54.7	2.5
		2.5	.4	1.0	2.2	4.6	
		.2	.0	.3	.6	1.3	
COLUMNS		241	230	675	688	757	2691
TOTAL		9.3	8.8	20.0	20.5	29.5	100.0

(CONTINUED)

LAKE	DAYOFWK										ROW COL TOT	PCT PCT PCT	HOW TOTAL
	COUNT	MONDAY		THURSDAY		FRIDAY		SATURDAY		SUNDAY			
	I	1	I	4	I	5	I	6	I	7			
	I	I	I	I	I	I	I	I	I	I			
HIGGINS	9	I	16	I	26	I	51	I	68	I	77	I	238
		I	6.7	I	10.9	I	21.4	I	28.6	I	32.4	I	9.2
		I	6.6	I	11.3	I	7.6	I	9.9	I	10.6	I	
		I	.6	I	1.0	I	2.5	I	2.6	I	3.6	I	
ST HELEN	10	I	54	I	83	I	314	I	153	I	105	I	714
		I	7.6	I	11.6	I	44.0	I	22.1	I	14.7	I	27.5
		I	22.4	I	36.1	I	46.5	I	23.0	I	13.7	I	
		I	2.1	I	3.2	I	12.1	I	6.1	I	4.6	I	
CHIPPEWA	11	I	5	I	5	I	22	I	41	I	47	I	120
		I	4.2	I	4.2	I	18.3	I	34.2	I	39.2	I	4.6
		I	2.1	I	2.2	I	3.3	I	6.0	I	6.1	I	
		I	.2	I	.2	I	.8	I	1.6	I	1.8	I	
CLEAR	12	I	9	I	8	I	14	I	20	I	17	I	64
		I	14.1	I	12.5	I	15.5	I	31.3	I	26.6	I	2.5
		I	3.7	I	3.5	I	1.5	I	2.9	I	2.2	I	
		I	.3	I	.3	I	.4	I	.8	I	.7	I	
NIXON	13	I	21	I	1	I	31	I	51	I	83	I	197
		I	11.2	I	.5	I	16.6	I	27.3	I	44.4	I	7.2
		I	8.7	I	.4	I	4.5	I	7.4	I	10.8	I	
		I	.8	I	.5	I	1.2	I	2.0	I	3.2	I	
BIG STAR	14	I	7	I	2	I	21	I	46	I	37	I	112
		I	6.3	I	1.8	I	17.9	I	41.1	I	33.6	I	4.3
		I	2.9	I	.9	I	3.6	I	6.7	I	4.8	I	
		I	.3	I	.1	I	.8	I	1.8	I	1.4	I	
WIGGINS	15	I	26	I	4	I	29	I	35	I	73	I	161
		I	12.4	I	2.5	I	18.0	I	21.7	I	45.3	I	6.2
		I	8.3	I	1.7	I	4.3	I	5.1	I	9.5	I	
		I	.8	I	.2	I	1.1	I	1.3	I	2.8	I	
BIG TWIN	16	I	10	I	3	I	15	I	15	I	22	I	65
		I	15.4	I	4.6	I	23.1	I	23.1	I	33.8	I	2.5
		I	4.1	I	1.3	I	2.2	I	2.2	I	2.9	I	
		I	.4	I	.1	I	.5	I	.6	I	.8	I	
COLUMN TOTAL			241		236		675		689		767		2601
			9.3		8.8		26.4		26.5		29.5		100.0

NUMBER OF MISSING OBSERVATIONS = 1

***** CROSS TABULATION OF *****
 LAKE BY TIME

PAGE 1 OF 4

TABLE A2 Cross Tabulation For 16 Survey Sites Number and Percentage of Interviews By Time of Day															PAGE 1 OF 4							
LAKE	COUNT ROW PCT COL PCT TOT PCT	TIME										ROW TOTAL										
		16-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4											
		1	1	2	3	4	5	6	7	8	9	10										
AUSTIN	1	I	8	I	9	I	5	I	7	I	6	I	9	I	138							
		I	5.8	I	6.5	I	4.3	I	5.1	I	4.3	I	6.5	I	5.3							
		I	14.8	I	10.5	I	8.1	I	8.0	I	5.1	I	2.6	I								
		I	.3	I	.3	I	.2	I	.3	I	.2	I	.3	I								
ORCHARD	2	I	17	I	26	I	15	I	15	I	16	I	18	I	383							
		I	5.0	I	8.6	I	5.3	I	5.0	I	5.3	I	5.9	I	11.6							
		I	31.5	I	30.2	I	21.6	I	17.2	I	13.7	I	5.2	I								
		I	.7	I	1.0	I	.5	I	.6	I	.6	I	.7	I								
WOLVERINE	3	I	3	I	2	I	3	I	0	I	4	I	4	I	56							
		I	5.4	I	3.6	I	5.4	I	0	I	7.1	I	7.1	I	2.2							
		I	5.6	I	2.3	I	4.1	I	0	I	3.4	I	1.2	I								
		I	.1	I	.1	I	.1	I	0	I	.2	I	.2	I								
SHERMAN	4	I	4	I	4	I	1	I	4	I	4	I	4	I	135							
		I	3.8	I	3.8	I	1.3	I	3.8	I	3.8	I	3.8	I	4.0							
		I	7.4	I	4.7	I	1.4	I	4.6	I	3.4	I	1.2	I								
		I	.2	I	.2	I	.6	I	.2	I	.2	I	.2	I								
FENTON	5	I	6	I	7	I	3	I	10	I	10	I	14	I	242							
		I	2.5	I	2.9	I	3.7	I	4.1	I	4.1	I	5.8	I	9.3							
		I	11.1	I	8.1	I	12.2	I	11.5	I	8.5	I	4.1	I								
		I	.2	I	.3	I	.3	I	.4	I	.4	I	.5	I								
UNION	6	I	0	I	0	I	0	I	1	I	1	I	2	I	17							
		I	0	I	0	I	0	I	5.9	I	5.9	I	11.8	I	.7							
		I	0	I	0	I	0	I	1.1	I	.9	I	.6	I								
		I	0	I	0	I	0	I	.3	I	.6	I	.1	I								
SWAN	7	I	0	I	3	I	0	I	2	I	3	I	2	I	18							
		I	0	I	16.7	I	0	I	11.1	I	16.7	I	11.1	I	.7							
		I	0	I	3.5	I	0	I	2.3	I	2.6	I	.6	I								
		I	0	I	.1	I	0	I	.1	I	.1	I	.1	I								
MUSKRAT	8	I	2	I	4	I	3	I	2	I	3	I	4	I	64							
		I	3.1	I	6.3	I	4.7	I	3.1	I	4.7	I	6.3	I	2.5							
		I	3.7	I	4.7	I	4.1	I	2.3	I	2.6	I	1.2	I								
		I	.1	I	.2	I	.1	I	.1	I	.1	I	.2	I								
COLUMN TOTAL		54		86		74		87		117		344		376		379		211		209		2601
		2.1		3.3		2.8		3.3		4.5		13.2		14.5		14.6		8.1		8.0		100.0

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***** C R O S S T A B U L A T I O N O F *****
 LAKE BY TIME
 ***** PAGE 2 OF 4

LAKE	TIME										ROW TOTAL
	COUNT	14-5		5-6		6-7		7-8			
	ROW PCT	I		I		I		I			
	COL PCT	I		I		I		I			
	TOT PCT	I	11	I	12	I	13	I	14	I	
AUSTIN	1	I	12	I	6	I	5	I	4	I	138
		I	8.7	I	4.3	I	3.6	I	2.9	I	5.3
		I	6.5	I	3.3	I	3.2	I	2.8	I	
		I	.5	I	.2	I	.2	I	.2	I	
ORCHARD	2	I	20	I	20	I	19	I	15	I	303
		I	6.6	I	6.6	I	6.3	I	5.0	I	11.6
		I	10.8	I	11.1	I	12.1	I	10.6	I	
		I	.8	I	.8	I	.7	I	.6	I	
WOLVERINE	3	I	2	I	1	I	8	I	4	I	56
		I	3.6	I	1.8	I	14.3	I	7.1	I	2.2
		I	1.1	I	.6	I	5.1	I	2.8	I	
		I	.1	I	.6	I	.3	I	.2	I	
SHERMAN	4	I	12	I	9	I	4	I	5	I	105
		I	11.4	I	8.6	I	3.8	I	4.8	I	4.0
		I	6.5	I	5.0	I	2.5	I	3.5	I	
		I	.5	I	.3	I	.2	I	.2	I	
FENTON	5	I	26	I	17	I	19	I	10	I	242
		I	10.7	I	7.6	I	7.9	I	4.1	I	9.3
		I	14.1	I	9.4	I	12.1	I	7.0	I	
		I	1.6	I	.7	I	.7	I	.4	I	
UNION	6	I	0	I	1	I	1	I	0	I	17
		I	0	I	5.9	I	5.9	I	3	I	.7
		I	0	I	.6	I	.5	I	0	I	
		I	0	I	.0	I	.0	I	0	I	
SWAN	7	I	2	I	2	I	3	I	0	I	18
		I	11.1	I	11.1	I	6	I	0	I	.7
		I	1.1	I	1.1	I	6	I	0	I	
		I	.1	I	.1	I	6	I	0	I	
MUSKRAT	8	I	6	I	4	I	6	I	3	I	64
		I	9.4	I	6.3	I	9.4	I	4.7	I	2.5
		I	3.2	I	2.2	I	3.8	I	2.1	I	
		I	.2	I	.2	I	.2	I	.1	I	
COLUMN TOTAL			185		186		157		142	2661	
			7.1		6.9		5.6		5.5	106.0	

***** CROSS TABULATION OF *****
 LAKE BY TIME
 ***** PAGE 3 OF 4

LAKE	TIME																				ROW TOTAL		
	COUNT	1-7		7-8		8-9		9-10		10-11		11-12		12-1		1-2		2-3		3-4			
	ROW PCT	1-7		7-8		8-9		9-10		10-11		11-12		12-1		1-2		2-3		3-4			
	TOT PCT	1	I	2	I	3	I	4	I	5	I	6	I	7	I	8	I	9	I	10		I	
HIGGINS	9	I	6	I	5	I	5	I	8	I	10	I	23	I	35	I	39	I	26	I	20	I	238
		I	0	I	2.1	I	2.1	I	3.4	I	4.2	I	9.7	I	14.7	I	16.4	I	10.9	I	8.4	I	9.2
		I	0	I	5.8	I	6.3	I	9.2	I	8.5	I	6.7	I	9.3	I	10.3	I	12.3	I	9.6	I	
		I	0	I	.2	I	.2	I	.3	I	.4	I	.9	I	1.3	I	1.5	I	1.0	I	.8	I	
ST HELEN	10	I	8	I	10	I	13	I	16	I	32	I	222	I	96	I	94	I	37	I	42	I	713
		I	1.1	I	1.4	I	2.5	I	2.2	I	4.5	I	31.1	I	12.6	I	13.2	I	5.2	I	5.9	I	27.4
		I	14.8	I	11.6	I	24.3	I	18.4	I	27.4	I	64.5	I	23.9	I	24.8	I	17.5	I	20.1	I	
		I	.3	I	.4	I	.7	I	.6	I	1.2	I	8.5	I	3.5	I	3.6	I	1.4	I	1.6	I	
CHIPPEWA	11	I	1	I	1	I	1	I	3	I	4	I	7	I	24	I	24	I	16	I	13	I	119
		I	.3	I	.8	I	.8	I	2.5	I	3.4	I	5.9	I	23.2	I	20.2	I	13.4	I	10.9	I	4.6
		I	1.9	I	1.2	I	1.4	I	3.4	I	3.4	I	2.0	I	5.4	I	6.3	I	7.5	I	6.2	I	
		I	.1	I	.6	I	.6	I	.1	I	.2	I	.3	I	.9	I	.9	I	.6	I	.5	I	
CLEAR	12	I	1	I	1	I	2	I	1	I	3	I	5	I	10	I	9	I	3	I	8	I	53
		I	1.6	I	1.6	I	3.2	I	1.6	I	4.8	I	7.9	I	15.9	I	14.3	I	4.8	I	12.7	I	2.4
		I	1.9	I	1.2	I	2.7	I	1.1	I	2.6	I	1.5	I	2.7	I	2.4	I	1.4	I	3.8	I	
		I	.1	I	.6	I	.1	I	.0	I	.1	I	.2	I	.4	I	.3	I	.1	I	.3	I	
WIXON	13	I	3	I	6	I	6	I	9	I	3	I	9	I	23	I	40	I	19	I	16	I	187
		I	1.6	I	3.2	I	3.2	I	4.8	I	1.6	I	4.8	I	12.3	I	21.4	I	10.2	I	8.5	I	7.2
		I	5.8	I	7.0	I	8.1	I	16.3	I	2.6	I	2.6	I	5.1	I	10.6	I	9.0	I	7.7	I	
		I	.1	I	.2	I	.2	I	.3	I	.1	I	.3	I	.9	I	1.5	I	.7	I	.6	I	
BIG STAR	14	I	0	I	3	I	1	I	5	I	5	I	7	I	17	I	17	I	7	I	9	I	112
		I	0	I	2.7	I	.9	I	4.5	I	4.5	I	6.3	I	15.2	I	15.2	I	6.3	I	8.0	I	4.3
		I	0	I	3.5	I	1.4	I	5.7	I	4.3	I	2.0	I	4.5	I	4.5	I	3.3	I	4.3	I	
		I	0	I	.1	I	.0	I	.2	I	.2	I	.3	I	.7	I	.7	I	.3	I	.3	I	
WIGGINS	15	I	1	I	4	I	2	I	2	I	10	I	9	I	25	I	21	I	19	I	20	I	161
		I	.6	I	2.5	I	1.2	I	1.2	I	6.2	I	5.6	I	15.5	I	13.0	I	11.8	I	12.4	I	6.2
		I	1.9	I	4.7	I	2.7	I	2.3	I	8.5	I	2.6	I	6.6	I	5.5	I	9.0	I	9.6	I	
		I	.6	I	.2	I	.1	I	.1	I	.4	I	.3	I	1.0	I	.8	I	.7	I	.8	I	
BIG TWIN	15	I	0	I	1	I	1	I	2	I	3	I	5	I	8	I	13	I	5	I	4	I	55
		I	0	I	1.5	I	1.5	I	3.1	I	4.6	I	7.7	I	12.3	I	20.0	I	7.7	I	6.2	I	2.5
		I	0	I	1.2	I	1.4	I	2.3	I	2.6	I	1.5	I	2.1	I	3.4	I	2.4	I	1.9	I	
		I	0	I	.0	I	.0	I	.1	I	.1	I	.2	I	.3	I	.5	I	.2	I	.2	I	
COLUMN TOTAL		54		86		74		87		117		344		376		379		211		209		2601	
(CONTINUED)		2.1		3.3		2.8		3.3		4.5		13.2		14.5		14.6		8.1		8.0		100.0	

 LAKE BY TIME
 ***** PAGE 4 OF 4

LAKE	TIME										ROW TOTAL
	COUNT	I		5-6		6-7		7-8			
	ROW PCT	I		I		I		I			
	COL PCT	I		I		I		I			
TOT PCT	I	11	I	12	I	13	I	14	I		
HIGGINS	9	I	20	I	18	I	13	I	16	I	238
		I	8.4	I	7.6	I	5.5	I	6.7	I	9.2
		I	13.8	I	10.0	I	3.3	I	11.3	I	
		I	.8	I	.7	I	.5	I	.6	I	
ST HELEN	10	I	27	I	45	I	37	I	35	I	713
		I	3.8	I	6.3	I	5.2	I	4.9	I	27.4
		I	14.6	I	25.0	I	23.6	I	24.6	I	
		I	1.5	I	1.7	I	1.4	I	1.3	I	
CHIPPEWA	11	I	10	I	5	I	5	I	4	I	119
		I	8.4	I	4.2	I	5.0	I	3.4	I	4.6
		I	5.4	I	2.8	I	3.8	I	2.8	I	
		I	.4	I	.2	I	.2	I	.2	I	
CLEAR	12	I	7	I	8	I	2	I	3	I	53
		I	11.1	I	12.7	I	3.2	I	4.8	I	2.4
		I	3.8	I	4.4	I	1.3	I	2.1	I	
		I	.3	I	.3	I	.1	I	.1	I	
NIXON	13	I	15	I	14	I	11	I	13	I	187
		I	8.0	I	7.5	I	5.9	I	7.0	I	7.2
		I	8.1	I	7.8	I	7.0	I	9.2	I	
		I	.6	I	.5	I	.4	I	.5	I	
BIG STAR	14	I	8	I	11	I	9	I	14	I	112
		I	7.1	I	9.8	I	7.1	I	12.5	I	4.3
		I	4.3	I	6.1	I	5.1	I	9.9	I	
		I	.3	I	.4	I	.3	I	.5	I	
WIGGINS	15	I	12	I	14	I	10	I	12	I	151
		I	7.5	I	8.7	I	6.2	I	7.5	I	6.2
		I	6.5	I	7.8	I	6.4	I	8.5	I	
		I	.5	I	.5	I	.4	I	.5	I	
BIG TWIN	16	I	6	I	5	I	8	I	4	I	55
		I	9.2	I	7.7	I	12.3	I	6.2	I	2.5
		I	3.2	I	2.8	I	5.1	I	2.8	I	
		I	.2	I	.2	I	.3	I	.2	I	
COLUMN TOTAL		185		180		157		142		2601	
		7.1		6.9		5.0		5.5		106.0	

NUMBER OF MISSING OBSERVATIONS = 3

LAKE	Cross Tabulation For 16 Survey Sites Number and Percentage of People Bringing Boats To Public Access Sites						
	COUNT	BOAT			ROW		
	ROW PCT	140 BOAT	TRAILERE	CAR TOP	ROW		
	COL PCT	0			TOTAL		
	TOT PCT	1	2	3			
AUSTIN	1	19	116	9	138		
		13.8	79.7	5.5	5.3		
		1.5	9.6	3.3			
		.7	4.2	.3			
ORCHARD	2	22	259	23	304		
		7.2	85.2	7.6	11.7		
		1.7	22.5	13.5			
		.8	10.0	.9			
WOLVERINE	3	8	40	9	56		
		14.3	71.4	14.3	2.2		
		.6	3.5	4.7			
		.3	1.5	.3			
SHERMAN	4	54	38	14	106		
		50.9	35.8	13.2	4.1		
		4.2	3.3	9.2			
		2.1	1.5	.5			
FENTON	5	13	223	6	242		
		5.4	92.1	2.5	9.3		
		1.0	19.4	3.5			
		.5	8.6	.2			
UNION	6	6	9	2	17		
		35.3	52.9	11.8	.7		
		.5	.8	1.2			
		.2	.3	.1			
SWAN	7	1	4	12	17		
		5.9	23.5	73.6	.7		
		.1	.3	7.6			
		.0	.2	.5			
MUSKRAT	8	12	29	23	64		
		18.8	45.3	35.9	2.5		
		.9	2.5	13.5			
		.5	1.1	.9			
COLUMN		1243	1149	171	2663		
TOTAL		49.3	44.1	6.5	100.0		

(CONTINUED)

LAKE	BOAT										ROW TOTAL
	COUNT	I									
	ROW PCT	IND BOAT	TRAILERE			CAR TOP					
	COL PCT	I									
	TOT PCT	I	1	I	2	I	3	I			
-----I-----I-----I-----I-----I											
HIGGINS	9	I	136	I	99	I	3	I		238	
		I	57.1	I	41.6	I	1.3	I		9.1	
		I	10.6	I	8.6	I	1.8	I			
		I	5.2	I	3.8	I	.1	I			
-----I-----I-----I-----I-----I											
ST HELEN	10	I	584	I	116	I	23	I		713	
		I	81.9	I	14.9	I	3.2	I		27.4	
		I	45.5	I	9.2	I	13.5	I			
		I	22.4	I	4.1	I	.9	I			
-----I-----I-----I-----I-----I											
CHIPPEWA	11	I	94	I	22	I	3	I		119	
		I	79.6	I	18.5	I	2.5	I		4.6	
		I	7.3	I	1.9	I	1.8	I			
		I	3.6	I	.8	I	.1	I			
-----I-----I-----I-----I-----I											
CLEAR	12	I	36	I	15	I	13	I		64	
		I	56.3	I	23.4	I	20.3	I		2.5	
		I	2.8	I	1.3	I	7.5	I			
		I	1.4	I	.6	I	.5	I			
-----I-----I-----I-----I-----I											
WIXON	13	I	66	I	108	I	13	I		187	
		I	35.3	I	57.8	I	7.1	I		7.2	
		I	5.1	I	9.4	I	7.6	I			
		I	2.5	I	4.1	I	.5	I			
-----I-----I-----I-----I-----I											
BIG STAR	14	I	61	I	44	I	7	I		112	
		I	54.5	I	39.3	I	6.3	I		4.3	
		I	4.8	I	3.8	I	4.1	I			
		I	2.3	I	1.7	I	.3	I			
-----I-----I-----I-----I-----I											
WIGGINS	15	I	121	I	30	I	10	I		161	
		I	75.2	I	18.6	I	6.2	I		6.2	
		I	9.4	I	2.6	I	5.8	I			
		I	4.6	I	1.2	I	.4	I			
-----I-----I-----I-----I-----I											
BIG TWIN	16	I	50	I	13	I	2	I		65	
		I	76.9	I	20.0	I	3.1	I		2.5	
		I	3.9	I	1.1	I	1.2	I			
		I	1.9	I	.5	I	.1	I			
-----I-----I-----I-----I-----I											
COLUMN			1283		1149		171			2613	
TOTAL			49.3		44.1		6.6			100.0	

NUMBER OF MISSING OBSERVATIONS = 5

***** CROSS TABULATION OF *****
 LAKE BY MIN15

TABLE A4
 Cross Tabulation For 16 Survey Sites
 Travel Time To Destination Public Access Sites

LAKE	COUNT ROW PCT COL PCT TOT PCT	MIN15										ROW TOTAL
		0	1	2	3	4	5	6	7	8	9	
AUSTIN	1	59	66	16	2	0	0	0	0	0	0	138
		42.8	47.8	7.2	1.4	0	0	0	0	0	0	5.3
		5.3	10.2	3.2	1.9	0	0	0	0	0	0	
		2.3	2.5	.4	.1	0	0	0	0	0	0	
ORCHARD	2	52	106	93	34	13	1	3	0	0	0	304
		17.1	34.9	30.6	11.2	4.3	.3	1.0	0	0	0	11.7
		4.7	16.4	30.1	31.5	14.3	5.3	4.1	0	0	0	
		2.0	4.1	3.6	1.3	.5	.0	.1	0	0	0	
WOLVERINE	3	23	9	11	9	3	0	1	0	0	0	56
		41.1	16.1	19.6	16.1	5.4	0	1.8	0	0	0	2.2
		2.1	1.4	3.6	8.3	3.3	0	1.4	0	0	0	
		.9	.3	.4	.3	.1	0	.0	0	0	0	
SHERMAN	4	18	59	22	2	3	0	1	0	0	0	106
		17.0	55.7	20.8	1.9	2.8	0	.9	0	0	0	4.1
		1.6	9.1	7.1	1.9	3.3	0	1.4	0	0	0	
		.7	2.3	.8	.1	.1	0	.0	0	0	0	
FENTON	5	50	114	52	9	7	5	2	1	0	0	242
		20.7	47.1	21.5	3.7	2.9	2.1	.8	.4	0	0	9.3
		4.5	17.6	15.8	8.3	7.7	26.3	2.7	6.7	0	0	
		1.9	4.4	2.0	.3	.3	.2	.1	.0	0	0	
UNION	6	6	6	3	0	0	0	0	0	0	0	17
		35.3	35.3	17.6	0	0	0	0	0	0	0	.7
		.5	.9	1.0	0	0	0	0	0	0	0	
		.2	.2	.1	0	0	0	0	0	0	0	
SWAN	7	8	2	2	2	2	0	1	0	0	0	18
		44.4	11.1	11.1	11.1	11.1	0	5.6	0	0	0	.7
		.7	.3	.5	1.9	2.2	0	1.4	0	0	0	
		.3	.1	.1	.1	.1	0	.0	0	0	0	
MUSKRAT	8	18	30	14	1	1	0	0	0	0	0	64
		28.1	46.9	21.9	1.6	1.6	0	0	0	0	0	2.5
		1.6	4.6	4.5	.9	1.1	0	0	0	0	0	
		.7	1.2	.5	.0	.0	0	0	0	0	0	
COLUMN TOTAL		1158	647	309	108	91	19	73	15	69	3	2593
		42.7	25.0	11.3	4.2	3.5	.7	2.8	.5	2.7	.1	100.0

***** CROSS TABULATION OF *****
 LAKE BY MIN15

LAKE	COUNT ROW PCT COL PCT TOT PCT	MIN15										ROW TOTAL
		0	1	2	3	4	5	6	7	8	9	
		I	I	I	I	I	I	I	I	I	I	
HIGGINS	9	I 127	I 49	I 14	I 3	I 4	I 1	I 9	I 3	I 6	I 0	234
		I 54.3	I 20.9	I 5.6	I 1.3	I 1.7	I .4	I 3.8	I 1.3	I 2.6	I 0	9.0
		I 11.5	I 7.6	I 4.5	I 2.8	I 4.4	I 5.3	I 12.3	I 26.0	I 8.7	I 0	
		I 4.9	I 1.9	I .5	I .1	I .2	I .6	I .3	I .1	I .2	I 0	
ST HELEN	10	I 582	I 75	I 19	I 5	I 5	I 2	I 3	I 0	I 7	I 1	713
		I 81.6	I 10.5	I 2.7	I .3	I .7	I .3	I .4	I 0	I 1.0	I .1	27.5
		I 52.5	I 11.6	I 6.1	I 5.6	I 5.5	I 10.5	I 4.1	I 0	I 10.1	I 33.3	
		I 22.4	I 2.9	I .7	I .2	I .2	I .1	I .1	I 0	I .3	I .0	
CHIPPEWA	11	I 15	I 23	I 7	I 5	I 4	I 3	I 17	I 2	I 14	I 1	119
		I 12.6	I 19.3	I 5.9	I 4.2	I 3.4	I 2.5	I 14.3	I 1.7	I 11.8	I .8	4.6
		I 1.4	I 3.6	I 2.3	I 4.6	I 4.4	I 15.8	I 23.3	I 13.3	I 20.3	I 33.3	
		I .6	I .9	I .3	I .2	I .2	I .1	I .7	I .1	I .5	I .0	
CLEAR	12	I 24	I 12	I 3	I 2	I 4	I 0	I 0	I 0	I 5	I 0	63
		I 38.1	I 19.0	I 4.8	I 3.2	I 6.3	I 0	I 0	I 0	I 7.9	I 0	2.4
		I 2.2	I 1.9	I 1.0	I 1.9	I 4.4	I 0	I 0	I 0	I 7.2	I 0	
		I .9	I .5	I .1	I .1	I .2	I 0	I 0	I 0	I .2	I 0	
WIXON	13	I 18	I 36	I 42	I 25	I 26	I 2	I 7	I 2	I 6	I 1	185
		I 9.7	I 19.5	I 22.7	I 13.5	I 14.1	I 1.1	I 3.8	I 1.1	I 3.2	I .5	7.1
		I 1.6	I 5.6	I 13.5	I 23.1	I 28.6	I 10.5	I 9.6	I 13.3	I 8.7	I 33.3	
		I .7	I 1.4	I 1.6	I 1.0	I 1.0	I .1	I .3	I .1	I .2	I .0	
BIG STAR	14	I 4	I 3	I 1	I 3	I 5	I 3	I 24	I 7	I 24	I 0	109
		I 3.7	I 2.8	I .9	I 2.8	I 4.6	I 2.8	I 22.0	I 6.4	I 22.0	I 0	4.2
		I .4	I .5	I .3	I 2.8	I 5.5	I 15.8	I 32.9	I 46.7	I 34.8	I 0	
		I .2	I .1	I .6	I .1	I .2	I .1	I .9	I .3	I .9	I 0	
HIGGINS	15	I 78	I 39	I 14	I 5	I 12	I 2	I 5	I 0	I 5	I 0	161
		I 48.4	I 24.2	I 8.7	I 3.1	I 7.5	I 1.2	I 3.1	I 0	I 3.1	I 0	6.2
		I 7.0	I 6.0	I 4.5	I 4.6	I 13.2	I 10.5	I 6.8	I 0	I 7.2	I 0	
		I 3.0	I 1.5	I .5	I .2	I .5	I .1	I .2	I 0	I .2	I 0	
BIG TWIN	16	I 26	I 18	I 2	I 0	I 2	I 0	I 0	I 0	I 2	I 0	64
		I 40.6	I 28.1	I 3.1	I 0	I 3.1	I 0	I 0	I 0	I 3.1	I 0	2.5
		I 2.3	I 2.8	I .6	I 0	I 2.2	I 0	I 0	I 0	I 2.9	I 0	
		I 1.0	I .7	I .1	I 0	I .1	I 0	I 0	I 0	I .1	I 0	
COLUMN TOTAL		1138	647	309	118	91	19	73	15	69	3	2593
		42.7	25.0	11.9	4.2	3.5	.7	2.8	.6	2.7	.1	100.0

***** CROSS TABULATION OF *****
 LAKE BY SITEUSE

TABLE A5 Cross Tabulation For 16 Survey Sites Number and Percentage of Primary Site Use Categories														
LAKE	COUNT	SITEUSE										ROW TOTAL		
	ROW PCT	1	2	3	4	5	6	7	8	9				
	COL PCT	1	2	3	4	5	6	7	8	9				
AUSTIN	1	46	71	0	8	9	0	7	0	3	138			
	I	29.0	51.4	0	5.3	6.5	0	5.1	0	2.2	5.3			
	I	5.9	9.4	0	1.3	4.7	0	25.0	0	1.1				
	I	1.5	2.7	0	.3	.3	0	.3	0	.1				
ORCHARD	2	167	57	0	4	53	2	0	4	4	301			
	I	55.5	18.9	0	1.3	20.9	.7	0	1.3	1.3	11.5			
	I	24.5	7.5	0	.7	33.2	19.2	0	10.3	1.5				
	I	6.5	2.2	0	.2	2.4	.1	0	.2	.2				
WOLVERINE	3	24	35	0	1	4	0	0	0	2	56			
	I	25.0	62.5	0	1.8	7.1	0	0	0	3.6	2.2			
	I	2.0	4.6	0	.2	2.1	0	0	0	.7				
	I	.5	1.4	0	.3	.2	0	0	0	.1				
SHERMAN	4	10	46	0	38	4	3	0	6	3	104			
	I	9.6	38.5	0	36.5	3.8	2.9	0	5.8	2.9	4.3			
	I	1.5	5.3	0	6.3	2.1	27.3	0	15.4	1.1				
	I	.4	1.5	0	1.5	.2	.1	0	.2	.1				
FENTON	5	137	53	0	2	35	0	0	1	8	236			
	I	58.1	22.5	0	.8	14.9	0	0	.4	3.4	9.1			
	I	20.1	7.6	0	.3	18.4	0	0	2.6	3.0				
	I	5.3	2.6	0	.1	1.4	0	0	.0	.3				
UNION	6	2	9	0	0	1	0	0	0	5	17			
	I	11.8	52.9	0	0	5.9	0	0	0	29.4	.7			
	I	.3	1.2	0	0	.5	0	0	0	1.9				
	I	.1	.3	0	0	.0	0	0	0	.2				
SWAN	7	0	16	0	0	0	0	0	0	1	17			
	I	0	94.1	0	0	0	0	0	0	5.9	.7			
	I	0	2.1	0	0	0	0	0	0	.4				
	I	0	.6	0	0	0	0	0	0	.0				
MUSKRAT	8	4	55	0	0	0	0	0	0	4	63			
	I	6.3	37.3	0	0	0	0	0	0	6.3	2.4			
	I	.6	7.3	0	0	0	0	0	0	1.5				
	I	.2	2.1	0	0	0	0	0	0	.2				
COLUMN TOTAL		683	758	4	605	190	11	28	39	269	2587			
		20.4	29.3	.2	23.4	7.3	.4	1.1	1.5	10.4	160.0			

***** CROSSTABULATION OF *****
 LAKE BY SITEUSE

LAKE	SITEUSE																			ROW TOTAL	
	COJNT	I	IPL BOAT		FISH		HUNT		SWIM		SKI		SCUBA		SUN BATH PICNIC		OTHER				
	ROW PCT	I	COL PCT		I		I		I		I		I		I		I				
	TOT PCT	I	1	I	2	I	3	I	4	I	5	I	6	I	7	I	8	I	9		I
HIGGINS	9	I	92	I	40	I	0	I	43	I	10	I	4	I	5	I	2	I	42	I	238
		I	38.7	I	16.8	I	0	I	18.1	I	4.2	I	1.7	I	2.1	I	.8	I	17.6	I	9.2
		I	13.5	I	5.3	I	0	I	7.1	I	5.3	I	36.4	I	17.9	I	5.1	I	15.6	I	
		I	3.6	I	1.5	I	0	I	1.7	I	.4	I	.2	I	.2	I	.1	I	1.6	I	
ST HELEN	10	I	69	I	145	I	1	I	383	I	16	I	2	I	11	I	8	I	78	I	713
		I	9.7	I	20.3	I	.1	I	53.7	I	2.2	I	.3	I	1.5	I	1.1	I	10.9	I	27.6
		I	10.1	I	19.1	I	25.0	I	63.3	I	8.4	I	18.2	I	33.3	I	26.5	I	29.0	I	
		I	2.7	I	5.6	I	.0	I	14.8	I	.6	I	.1	I	.4	I	.3	I	3.0	I	
CHIPPEWA	11	I	15	I	18	I	0	I	35	I	6	I	0	I	0	I	4	I	21	I	120
		I	13.3	I	15.0	I	0	I	45.8	I	5.0	I	0	I	0	I	3.3	I	17.5	I	4.6
		I	2.3	I	2.4	I	0	I	9.1	I	3.2	I	0	I	0	I	16.3	I	7.8	I	
		I	.6	I	.7	I	0	I	2.1	I	.2	I	0	I	0	I	.2	I	.8	I	
CLEAR	12	I	8	I	26	I	0	I	8	I	4	I	3	I	0	I	4	I	14	I	64
		I	12.5	I	40.6	I	0	I	12.5	I	6.3	I	0	I	0	I	6.3	I	21.9	I	2.5
		I	1.2	I	3.4	I	0	I	1.3	I	2.1	I	0	I	0	I	10.3	I	5.2	I	
		I	.3	I	1.0	I	0	I	.3	I	.2	I	0	I	0	I	.2	I	.5	I	
WIXON	13	I	53	I	88	I	1	I	13	I	15	I	0	I	2	I	4	I	11	I	187
		I	28.3	I	47.1	I	.5	I	7.0	I	8.0	I	0	I	1.1	I	2.1	I	5.9	I	7.2
		I	7.9	I	11.6	I	25.0	I	2.1	I	7.9	I	0	I	7.1	I	16.3	I	4.1	I	
		I	2.3	I	3.4	I	.3	I	.5	I	.6	I	0	I	.1	I	.2	I	.4	I	
BIG STAR	14	I	35	I	25	I	0	I	5	I	16	I	0	I	1	I	2	I	26	I	110
		I	31.8	I	22.7	I	0	I	4.5	I	14.5	I	0	I	.9	I	1.8	I	23.6	I	4.3
		I	5.1	I	3.3	I	0	I	.8	I	8.4	I	0	I	3.6	I	5.1	I	9.7	I	
		I	1.4	I	1.0	I	0	I	.2	I	.6	I	0	I	.0	I	.1	I	1.0	I	
HIGGINS	15	I	29	I	64	I	1	I	21	I	5	I	0	I	1	I	3	I	36	I	160
		I	18.1	I	40.0	I	.6	I	13.1	I	3.1	I	0	I	.6	I	1.9	I	22.5	I	6.2
		I	4.2	I	8.4	I	25.0	I	3.5	I	2.6	I	0	I	3.6	I	7.7	I	13.4	I	
		I	1.1	I	2.5	I	.0	I	.8	I	.2	I	0	I	.0	I	.1	I	1.4	I	
BIG TWIN	16	I	7	I	16	I	1	I	24	I	2	I	0	I	1	I	1	I	11	I	63
		I	11.1	I	25.4	I	1.6	I	38.1	I	3.2	I	0	I	1.6	I	1.6	I	17.5	I	2.4
		I	1.0	I	2.1	I	25.0	I	4.5	I	1.1	I	0	I	3.6	I	2.6	I	4.1	I	
		I	.3	I	.6	I	.0	I	.9	I	.1	I	0	I	.0	I	.0	I	.4	I	
COLUMN			683		758		4		615		190		11		28		39		269		2597
TOTAL			20.4		29.3		.2		23.4		7.3		.4		1.1		1.5		10.4		100.0

NUMBER OF MISSING OBSERVATIONS = 22

***** C R O S S T A B U L A T I O N O F *****
 LAKE BY PARTY

TABLE A6

PAGE 1 OF 2

Cross Tabulation For 16 Survey Sites													
Total Numbers and Percentages for Party Size													
LAKE	COUNT ROW PCT COL PCT TOT PCT	PARTY									ROW TOTAL		
		1	2	3	4	5	6	7	8	9			
AUSTIN	1	23	55	27	16	8	5	1	2	0	137		
		16.8	40.1	19.7	11.7	5.8	3.6	.7	1.5	0	5.3		
		7.3	8.2	5.8	4.1	4.3	1.8	3.2	11.1	0			
		.9	2.1	1.6	.6	.3	.2	.8	.1	0			
ORCHARD	2	29	104	65	60	29	13	2	0	2	302		
		9.6	34.4	21.9	19.9	9.6	3.3	.7	0	.7	11.7		
		9.1	11.7	14.1	15.5	15.4	3.6	6.5	0	18.2			
		1.1	4.0	2.6	2.3	1.1	.4	.1	0	.1			
WOLVERINE	3	6	27	10	13	0	2	1	0	0	56		
		10.7	48.2	17.9	17.9	0	3.6	1.8	0	0	2.2		
		1.9	3.6	2.1	2.6	0	.7	3.2	0	0			
		.2	1.0	.4	.4	0	.1	.6	0	0			
SHERMAN	4	7	45	15	16	18	2	5	1	0	102		
		6.9	44.1	15.7	15.7	9.8	2.0	4.9	1.0	0	3.9		
		2.2	5.1	3.4	4.1	5.3	.7	15.1	5.6	0			
		.3	1.7	.6	.6	.4	.1	.2	.0	0			
FENTON	5	17	89	55	44	21	11	2	2	1	242		
		7.0	36.8	22.7	18.2	8.7	4.5	.8	.8	.4	9.4		
		5.4	10.0	11.8	11.4	11.2	3.9	6.5	11.1	9.1			
		.7	3.4	2.1	1.7	.8	.4	.1	.1	.6			
UNION	6	4	6	3	2	1	1	0	0	0	17		
		23.5	35.3	17.6	11.8	5.9	5.9	0	0	0	.7		
		1.3	.7	.5	.5	.5	.4	0	0	0			
		.2	.2	.1	.1	.0	.0	0	0	0			
SWAN	7	2	9	6	1	0	0	0	0	0	18		
		11.1	54.0	33.3	5.6	0	0	0	0	0	.7		
		.6	1.0	1.3	.3	0	0	0	0	0			
		.1	.3	.2	.0	0	0	0	0	0			
MUSKRAT	8	5	37	13	7	1	0	0	1	0	64		
		7.8	57.8	20.3	10.9	1.6	0	0	1.6	0	2.5		
		1.6	4.2	2.8	1.8	.5	0	0	5.6	0			
		.2	1.4	.5	.3	.0	0	0	.0	0			
COLUMN TOTAL		317	887	468	387	188	280	31	18	11	2537		
(CONTINUED)		12.3	34.3	13.1	15.6	7.3	16.8	1.2	.7	.4	100.0		

LAKE	COUNT ROW PCT COL PCT TOT PCT	PARTY									ROW TOTAL
		1	2	3	4	5	6	7	8	9	
HIGGINS	9	I 34	I 92	I 50	I 42	I 9	I 7	I 1	I 0	I 1	236
		I 14.4	I 39.0	I 21.2	I 17.8	I 3.8	I 3.0	I .4	I 0	I .4	9.1
		I 10.7	I 10.4	I 10.7	I 10.9	I 4.8	I 2.5	I 3.2	I 0	I 9.1	
		I 1.3	I 3.6	I 1.9	I 1.6	I .3	I .3	I .6	I 0	I .6	
ST HELEN	10	I 93	I 178	I 95	I 68	I 51	I 208	I 8	I 4	I 4	710
		I 13.1	I 25.1	I 13.5	I 9.6	I 7.2	I 29.3	I 1.1	I .6	I .6	27.4
		I 29.3	I 26.1	I 20.5	I 17.6	I 27.1	I 74.3	I 25.8	I 22.2	I 36.4	
		I 3.6	I 6.9	I 3.7	I 2.6	I 2.0	I 8.0	I .3	I .2	I .2	
CHIPPEWA	11	I 13	I 38	I 17	I 16	I 12	I 10	I 6	I 5	I 2	119
		I 10.9	I 31.9	I 14.3	I 13.4	I 10.1	I 8.4	I 5.0	I 4.2	I 1.7	4.6
		I 4.1	I 4.3	I 3.0	I 4.1	I 6.4	I 3.6	I 19.4	I 27.8	I 18.2	
		I .5	I 1.5	I .7	I .6	I .5	I .4	I .2	I .2	I .1	
CLEAR	12	I 17	I 27	I 8	I 3	I 3	I 3	I 0	I 0	I 0	61
		I 27.9	I 44.3	I 13.1	I 4.9	I 4.9	I 4.9	I 0	I 0	I 0	2.4
		I 5.4	I 3.0	I 1.7	I .8	I 1.6	I 1.1	I 0	I 0	I 0	
		I .7	I 1.0	I .3	I .1	I .1	I .1	I 0	I 0	I 0	
WIXON	13	I 19	I 66	I 33	I 40	I 18	I 8	I 2	I 0	I 1	187
		I 10.2	I 35.3	I 17.5	I 21.4	I 9.6	I 4.3	I 1.1	I 0	I .5	7.2
		I 6.0	I 7.4	I 7.1	I 10.3	I 9.6	I 2.9	I 6.5	I 0	I 9.1	
		I .7	I 2.6	I 1.3	I 1.5	I .7	I .3	I .1	I 0	I .0	
BIG STAR	14	I 15	I 43	I 19	I 23	I 6	I 5	I 1	I 0	I 0	112
		I 13.4	I 38.4	I 17.6	I 20.5	I 5.4	I 4.5	I .9	I 0	I 0	4.3
		I 4.7	I 4.8	I 4.1	I 5.9	I 3.2	I 1.8	I 3.2	I 0	I 0	
		I .6	I 1.7	I .7	I .9	I .2	I .2	I .6	I 0	I 0	
WIGGINS	15	I 24	I 51	I 35	I 29	I 13	I 6	I 1	I 2	I 0	161
		I 14.9	I 31.7	I 21.7	I 18.0	I 8.1	I 3.7	I .6	I 1.2	I 0	6.2
		I 7.6	I 5.7	I 7.5	I 7.5	I 6.9	I 2.1	I 3.2	I 11.1	I 0	
		I .9	I 2.0	I 1.4	I 1.1	I .5	I .2	I .0	I .1	I 0	
BIG TWIN	16	I 9	I 20	I 14	I 10	I 6	I 2	I 1	I 1	I 0	63
		I 14.3	I 31.7	I 22.2	I 15.9	I 9.5	I 3.2	I 1.6	I 1.6	I 0	2.4
		I 2.8	I 2.3	I 3.6	I 2.6	I 3.2	I .7	I 3.2	I 5.6	I 0	
		I .3	I .8	I .5	I .4	I .2	I .1	I .0	I .0	I 0	
COLUMN TOTAL		317	887	468	387	188	280	31	18	11	2597
		12.3	34.3	18.1	15.0	7.3	10.8	1.2	.7	.4	100.0

NUMBER OF MISSING OBSERVATIONS = 22

***** CROSS TABULATION OF *****
 LAKE BY INCOME

PAGE 1 OF 4

		INCOME											
		Cross Tabulation For 16 Survey Sites											
		Total Numbers and Percentages for Income Classes											
COUNT	I	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50				
ROW PCT	I	1	2	3	4	5	6	7	8	9	10	ROW TOTAL	
COL PCT	I	1	2	3	4	5	6	7	8	9	10		
TOT PCT	I	1	2	3	4	5	6	7	8	9	10		
AUSTIN	1	6	23	45	35	18	5	2	0	0	0	136	
	I	4.4	16.9	33.1	25.7	13.2	3.7	1.5	0	0	0	5.7	
	I	4.1	6.0	6.1	6.8	5.9	3.2	3.3	0	0	0		
	I	.2	1.0	1.9	1.5	.7	.2	.1	0	0	0		
ORCHARD	2	1	9	65	61	31	45	15	13	12	2	304	
	I	.3	3.0	21.4	20.1	20.1	14.8	4.9	4.3	3.9	.7	12.6	
	I	.7	2.3	3.9	11.8	19.9	28.8	24.6	40.6	80.0	13.3		
	I	.0	.4	2.7	2.5	2.5	1.9	.6	.5	.5	.1		
WOLVERINE	3	1	5	19	12	8	5	2	1	0	0	56	
	I	1.8	8.9	33.9	21.4	14.3	8.9	3.6	1.8	0	0	2.3	
	I	.7	1.3	2.6	2.3	2.6	3.2	3.3	3.1	0	0		
	I	.0	.2	.8	.5	.3	.2	.1	.0	0	0		
SHERMAN	4	10	23	36	21	10	3	1	1	0	0	105	
	I	9.5	21.9	34.3	20.0	9.5	2.9	1.0	1.0	0	0	4.4	
	I	6.9	6.0	4.9	4.1	3.3	1.9	1.6	3.1	0	0		
	I	.4	1.0	1.5	.9	.4	.1	.0	.0	0	0		
FENTON	5	8	20	71	52	43	24	9	5	0	2	240	
	I	3.3	8.3	29.6	21.7	17.9	10.0	3.7	2.1	0	.8	10.0	
	I	5.5	5.2	9.7	10.1	14.0	15.4	14.8	15.6	0	13.3		
	I	.3	.8	3.0	2.2	1.8	1.6	.4	.2	0	.1		
UNION	6	2	5	6	2	1	0	0	0	0	1	17	
	I	11.8	29.4	35.3	11.8	5.9	0	0	0	0	5.9	.7	
	I	1.4	1.3	.8	.4	.3	0	0	0	0	6.7		
	I	.1	.2	.2	.1	.0	0	0	0	0	.0		
SWAN	7	3	7	5	1	1	0	0	0	0	0	17	
	I	17.6	41.2	29.4	5.9	5.9	0	0	0	0	0	.7	
	I	2.1	1.8	.7	.2	.3	0	0	0	0	0		
	I	.1	.3	.2	.0	.0	0	0	0	0	0		
MUSKRAT	8	4	12	23	15	10	0	0	0	0	0	64	
	I	6.3	18.8	35.9	23.4	15.6	0	0	0	0	0	2.7	
	I	2.8	3.1	3.1	2.9	3.3	0	0	0	0	0		
	I	.2	.5	1.0	.6	.4	0	0	0	0	0		
COLUMN TOTAL		145	393	733	517	307	156	61	32	15	15	2406	
(CONTINUED)		6.0	15.9	30.5	21.5	12.8	6.5	2.5	1.3	.6	.6	100.0	

LAKE	INCOME			
	COUNT	I		
	ROW PCT	150+		ROW
	COL PCT	I		TOTAL
	TOT PCT	I	11 I	
-----I-----I				
AUSTIN	1	I	2 I	136
		I	1.5 I	5.7
		I	4.8 I	
		I	.1 I	
-----I-----I				
ORCHARD	2	I	20 I	304
		I	0.0 I	12.6
		I	47.6 I	
		I	.8 I	
-----I-----I				
WOLVERINE	3	I	3 I	56
		I	5.4 I	2.3
		I	7.1 I	
		I	.1 I	
-----I-----I				
SHERMAN	4	I	0 I	105
		I	0 I	4.4
		I	0 I	
		I	0 I	
-----I-----I				
FENTON	5	I	5 I	240
		I	2.5 I	10.0
		I	14.3 I	
		I	.2 I	
-----I-----I				
UNION	6	I	0 I	17
		I	0 I	.7
		I	0 I	
		I	0 I	
-----I-----I				
SWAN	7	I	0 I	17
		I	0 I	.7
		I	0 I	
		I	0 I	
-----I-----I				
MUSKRAT	8	I	0 I	64
		I	0 I	2.7
		I	0 I	
		I	0 I	
-----I-----I				
	COLJMN	42		2406
	TOTAL	1.7		100.0

(CONTINUE)

(CONTINUED)

***** CROSS TABULATION OF *****
 LAKE BY INCOME
 ***** PAGE 3 OF 4

LAKE	INCOME												ROW TOTAL
	COUNT												
	ROW PCT	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50				
	COL PCT	1	2	3	4	5	6	7	8	9	10		
	TOT PCT	1	2	3	4	5	6	7	8	9	10		
HIGGINS	9	13	19	82	54	41	16	5	1	1	2	239	
		5.5	8.0	34.5	22.7	17.2	6.7	2.1	.4	.4	.8	9.9	
		9.0	5.0	11.2	10.4	13.4	10.3	8.2	3.1	6.7	13.3		
		.5	.8	3.4	2.2	1.7	.7	.2	.0	.0	.1		
ST HELEN	10	43	111	153	118	46	26	15	5	0	5	525	
		8.2	21.1	29.1	22.5	8.8	5.0	2.9	1.0	0	1.0	21.8	
		29.7	29.0	20.9	22.8	15.0	16.7	24.6	15.6	0	33.3		
		1.8	4.6	6.4	4.9	1.9	1.1	.6	.2	0	.2		
CHIPPEWA	11	12	32	38	21	6	5	1	1	1	1	120	
		10.0	26.7	31.7	17.5	5.3	4.2	.8	.8	.8	.8	5.5	
		8.3	8.4	5.2	4.1	2.0	3.2	1.6	3.1	6.7	6.7		
		.5	1.3	1.6	.9	.2	.2	.0	.0	.0	.0		
CLEAR	12	9	13	21	10	5	1	1	0	1	1	62	
		14.5	21.6	33.9	16.1	8.1	1.6	1.6	0	1.6	1.6	2.6	
		6.2	3.4	2.9	1.9	1.6	.6	1.6	0	6.7	6.7		
		.4	.5	.9	.4	.2	.0	.0	0	.0	.0		
WIXON	13	9	24	74	41	24	9	3	3	0	0	187	
		4.8	12.8	39.6	21.9	12.8	4.8	1.6	1.6	0	0	7.8	
		6.2	6.3	15.1	7.9	7.8	5.8	4.9	9.4	0	0		
		.4	1.0	3.1	1.7	1.0	.4	.1	.1	0	0		
BIG STAR	14	7	19	37	27	10	8	3	0	0	0	111	
		6.3	17.1	33.3	24.3	9.0	7.2	2.7	0	0	0	4.6	
		4.8	5.0	5.0	5.2	3.3	5.1	4.9	0	0	0		
		.3	.8	1.5	1.1	.4	.3	.1	0	0	0		
HIGGINS	15	13	37	45	35	16	7	3	2	0	1	160	
		8.1	23.1	28.1	21.9	10.0	4.4	1.9	1.2	0	.5	6.7	
		9.0	9.7	5.1	6.8	5.2	4.5	4.9	6.3	0	6.7		
		.5	1.5	1.9	1.5	.7	.3	.1	.1	0	.0		
BIG TWIN	16	4	24	13	12	7	2	1	0	0	0	64	
		6.3	37.5	20.3	18.8	10.9	3.1	1.6	0	0	0	2.7	
		2.3	6.3	1.8	2.3	2.3	1.3	1.6	0	0	0		
		.2	1.6	.5	.5	.3	.1	.0	0	0	0		
COLUMN TOTAL		145	383	733	517	307	156	61	32	15	15	2406	
(CONTINUED)		6.0	15.9	30.5	21.5	12.8	6.5	2.5	1.3	.6	.6	100.0	

***** C R O S S T A B U L A T I O N O F *****
 LAKE BY INCOME
 ***** PAGE 4 OF 4

LAKE	INCOME			
	COUNT	I		ROW TOTAL
	ROW PCT	IS0+		
	COL PCT	I		
	TOT PCT	I	11 I	
		-I-----I		
HIGGINS	9	I	4 I	238
		I	1.7 I	9.9
		I	9.5 I	
		I	.2 I	
		-I-----I		
ST HELEN	10	I	3 I	525
		I	.5 I	21.8
		I	7.1 I	
		I	.1 I	
		-I-----I		
CHIPPEWA	11	I	2 I	120
		I	1.7 I	5.0
		I	4.8 I	
		I	.1 I	
		-I-----I		
CLEAR	12	I	0 I	62
		I	0 I	2.6
		I	0 I	
		I	0 I	
		-I-----I		
WIXON	13	I	0 I	187
		I	0 I	7.8
		I	0 I	
		I	0 I	
		-I-----I		
BIG STAR	14	I	0 I	111
		I	0 I	4.6
		I	0 I	
		I	0 I	
		-I-----I		
WIGGINS	15	I	1 I	160
		I	.6 I	6.7
		I	2.4 I	
		I	.6 I	
		-I-----I		
BIG TWIN	15	I	1 I	64
		I	1.5 I	2.7
		I	2.4 I	
		I	.6 I	
		-I-----I		
	COLJMN		42	24.6
	TOTAL		1.7	100.0

NUMBER OF MISSING OBSERVATIONS = 203

APPENDIX E

CONSUMER SURPLUS FIGURES FOR THE
16 SURVEY PUBLIC ACCESS SITES

TABLE A8

CONSUMER SURPLUS

AUSTIN LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	72,739	\$ 8.25	4,398
.75	55,683	9.00	3,130
1.50	42,669	9.75	2,298
2.25	33,101	10.50	1,763
3.00	25,692	11.25	1,347
3.75	19,849	12.00	1,070
4.50	14,936	12.75	872
5.25	11,568	13.50	713
6.00	9,013	14.25	614
6.75	6,993	15.00	495
7.50	5,507	15.75	396

CONSUMER SURPLUS = \$236,130

TABLE A9

CONSUMER SURPLUS

ORCHARD LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	115,799	\$ 8.25	8,092
.75	86,512	9.00	6,204
1.50	66,673	9.75	4,798
2.25	52,305	10.50	3,532
3.00	41,371	11.25	2,580
3.75	32,909	12.00	1,684
4.50	26,189	12.75	871
5.25	20,726	13.50	386
6.00	16,438	14.25	238
6.75	13,119	15.00	0
7.50	10,376	15.75	0

CONSUMER SURPLUS = \$383,160

TABLE A10

CONSUMER SURPLUS

WOLVERINE LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	14,863	\$8.25	421
.75	11,406	9.00	303
1.50	8,744	9.75	208
2.25	6,717	10.50	127
3.00	5,132	11.25	59
3.75	3,865	12.00	32
4.50	2,924	12.75	18
5.25	2,172	13.50	0
6.00	1,566	14.25	0
6.75	1,086	15.00	0
7.50	688	15.75	0

CONSUMER SURPLUS = \$45,249

TABLE A11

CONSUMER SURPLUS

SHERMAN LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	49,011	\$ 8.25	2,364
.75	37,329	9.00	1,568
1.50	28,576	9.75	1,153
2.25	21,853	10.50	830
3.00	16,837	11.25	554
3.75	12,950	12.00	369
4.50	9,975	12.75	265
5.25	7,484	13.50	185
6.00	5,651	14.25	150
6.75	4,278	15.00	104
7.50	3,206	15.75	0

CONSUMER SURPLUS = \$153,520

TABLE A12

CONSUMER SURPLUS

FENTON LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	83,391	\$ 8.25	1,708
.75	61,527	9.00	954
1.50	45,388	9.75	542
2.25	33,302	10.50	353
3.00	24,161	11.25	224
3.75	17,482	12.00	141
4.50	12,534	12.75	94
5.25	8,894	13.50	35
6.00	6,185	14.25	0
6.75	4,052	15.00	0
7.50	2,603	15.75	0

CONSUMER SURPLUS = \$227,680

TABLE A13

CONSUMER SURPLUS

UNION LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	6,119	\$ 8.25	937
.75	5,415	9.00	735
1.50	4,758	9.75	549
2.25	4,147	10.50	383
3.00	3,541	11.25	280
3.75	3,049	12.00	181
4.50	2,583	12.75	114
5.25	2,221	13.50	67
6.00	1,822	14.25	36
6.75	1,527	15.00	21
7.50	1,196	15.75	10

CONSUMER SURPLUS = \$29,773

TABLE A14

CONSUMER SURPLUS

SWAN LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	9,515	\$ 8.25	158
.75	7,350	9.00	93
1.50	5,682	9.75	65
2.25	4,337	10.50	50
3.00	3,229	11.25	29
3.75	2,381	12.00	14
4.50	1,705	12.75	7
5.25	1,187	13.50	0
6.00	834	14.25	0
6.75	511	15.00	0
7.50	338	15.75	0

CONSUMER SURPLUS = \$28,114

TABLE A15

CONSUMER SURPLUS

MUSKRAT LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	12,539	\$ 8.25	303
.75	9,502	9.00	188
1.50	7,199	9.75	119
2.25	5,515	10.50	92
3.00	4,161	11.25	78
3.75	3,092	12.00	64
4.50	2,188	12.75	55
5.25	1,578	13.50	41
6.00	1,106	14.25	32
6.75	766	15.00	0
7.50	477	15.75	0

CONSUMER SURPLUS = \$36,822

TABLE A16

CONSUMER SURPLUS

HIGGINS LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	33,110	\$ 8.25	2,358
.75	28,953	9.00	1,805
1.50	22,052	9.75	1,144
2.25	18,194	10.50	788
3.00	13,822	11.25	534
3.75	11,541	12.00	438
4.50	10,085	12.75	248
5.25	6,806	13.50	222
6.00	5,821	14.25	203
6.75	4,995	15.00	184
7.50	4,201	15.75	165

CONSUMER SURPLUS = \$125,860

TABLE A17

CONSUMER SURPLUS

LAKE ST. HELEN SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	114,129	\$ 8.25	1,719
.75	53,269	9.00	1,154
1.50	33,607	9.75	729
2.25	22,329	10.50	408
3.00	15,136	11.25	278
3.75	10,007	12.00	182
4.50	7,170	12.75	122
5.25	5,529	15.50	61
6.00	4,123	14.25	17
6.75	3,133	15.00	0
7.50	2,370	15.75	0

CONSUMER SURPLUS = \$202,290

TABLE A18

CONSUMER SURPLUS

CHIPPEWA LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	29,894	\$ 8.25	1,719
.75	23,827	9.00	1,154
1.50	18,836	9.75	729
2.25	14,878	10.50	408
3.00	11,536	11.25	278
3.75	9,253	12.00	182
4.50	7,170	12.75	122
5.25	5,529	13.50	61
6.00	4,123	14.25	17
6.75	3,133	15.00	0
7.50	2,370	15.75	0

CONSUMER SURPLUS = \$101,410

TABLE A19
CONSUMER SURPLUS

CLEAR LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	8,072	\$ 8.25	140
.75	5,415	9.00	89
1.50	3,841	9.75	51
2.25	2,752	10.50	19
3.00	1,989	11.25	0
3.75	1,459	12.00	0
4.50	1,082	12.75	0
5.25	776	13.50	0
6.00	527	14.25	0
6.75	342	15.00	0
7.50	220	15.75	0

CONSUMER SURPLUS = \$20,082

TABLE A20

CONSUMER SURPLUS

WIXON LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	23,451	\$ 8.25	2,252
.75	20,050	9.00	1,388
1.50	14,784	9.75	1,241
2.25	12,998	10.50	966
3.00	11,220	11.25	142
3.75	9,961	12.00	49
4.50	8,658	12.75	35
5.25	7,780	13.50	22
6.00	7,093	14.25	9
6.75	6,073	15.00	0
7.50	3,382	15.75	0

CONSUMER SURPLUS = \$98,665

TABLE A21

CONSUMER SURPLUS

BIG STAR LAKE ESTIMATED SITE BENEFITS

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	18,268	\$ 8.25	551
.75	15,743	9.00	363
1.50	12,904	9.75	293
2.25	9,800	10.50	237
3.00	6,905	11.25	188
3.75	5,015	12.00	35
4.50	3,494	12.75	0
5.25	1,834	13.50	0
6.00	1,416	14.25	0
6.75	1,067	15.00	0
7.50	732	15.75	0

CONSUMER SURPLUS = \$59,134

TABLE A22

CONSUMER SURPLUS

WIGGINS LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	18,035	\$ 8.25	1,210
.75	13,174	9.00	758
1.50	11,083	9.75	567
2.25	9,507	10.50	95
3.00	8,238	11.25	44
3.75	7,210	12.00	20
4.50	6,230	12.75	0
5.25	5,516	13.50	0
6.00	3,508	14.25	0
6.75	2,750	15.00	0
7.50	1,857	15.75	0

CONSUMER SURPLUS = \$67,350

TABLE A23

CONSUMER SURPLUS

BIG TWIN LAKE SITE BENEFIT ESTIMATION

COST	ESTIMATED NUMBER OF VISITORS	COST	ESTIMATED NUMBER OF VISITORS
\$.00	13,802	\$ 8.25	684
.75	10,797	9.00	415
1.50	8,440	9.75	293
2.25	6,571	10.50	171
3.00	5,142	11.25	134
3.75	3,957	12.00	110
4.50	3,066	12.75	73
5.25	2,394	13.50	49
6.00	1,857	14.25	24
6.75	1,441	15.00	0
7.50	1,063	15.75	0

CONSUMER SURPLUS = \$45,363

APPENDIX F

LOWER PENINSULA LAKE SITES:
ESTIMATED VISITATIONS AND DOLLAR BENEFITS

APPENDIX F

ESTIMATED VISITATIONS AND CONSUMER SURPLUS
MICHIGAN LOWER PENINSULA LAKE PUBLIC ACCESS SITES
(Waterways Division Administered)

<u>COUNTY</u>	<u>LAKE</u>	<u>(1975) VISITS</u>	<u>CONSUMER SURPLUS</u>
Allegan	Big Lake	18,237	64,582
	Duck Lake	20,236	70,707
	Green	4,498	10,043
	Selkirk	16,746	57,660
	Pike	15,025	46,433
	Miner	23,888	89,799
	Swan	22,712	83,367
	L. Sixteen	12,603	39,728
	Sheffer	12,395	35,534
Alpena	Fletcher Pond	9,344	37,493
Antrim	Ellsworth	4,753	13,627
	Clam	6,367	21,277
	Intermediate	8,496	30,699
	L. Bellaire	8,786	32,088
	Intermediate	8,496	30,699
	St. Clair	4,503	12,527
	Green	21,975	82,198
	L. of the Woods	7,307	19,905
	Torch	12,870	55,712
	Wilson	4,640	13,126
	Elk	11,947	48,719
	Birch	6,100	20,075
Barry	Middle	20,569	67,381
	Jordan	22,907	73,319
	Fine	25,775	85,414
	Clear	22,446	71,815
	Carter	16,396	49,774
	Duncan	18,552	63,033
	Long	11,135	48,587
	Bristol	21,028	66,154
	Leach	20,307	66,262
	Thornapple	5,917	20,498
Benzie	Platte	11,715	44,186
	Upper Herring	7,823	26,078
	Brooks	2,658	6,414

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Benzie (Continued)	Turtle	5,307	14,199
	Lower Herring	7,500	24,558
	Davis	3,224	8,272
	Stevens	5,502	14,963
	Herendeene	5,281	14,095
Berrien	Paw Paw-W	29,489	120,562
	Paw Paw-E	29,489	120,562
	Black	11,979	34,770
Branch	Randall	24,643	73,637
	Coldwater	27,942	98,713
	Marble	28,249	51,863
	L. of the Woods	27,055	84,287
	Gilead	15,176	43,534
	Cary	17,800	45,803
	L. George	23,658	69,444
	Matteson	17,771	54,002
	Lavine	14,633	39,530
	Middle	16,595	44,392
	Union	6,119	29,773
	Craig	21,953	62,263
Calhoun	Nottawa	25,093	73,903
	Goguac	39,958	132,134
	Lanes	24,775	65,295
	Duck	40,453	131,997
	Warner	19,112	55,438
	Upper Brace	29,591	83,028
	Lee	16,885	48,906
	Prairie	23,120	65,753
	Winnepeg	24,813	66,385
Cass	Fish	22,287	77,112
	Magician	21,849	80,182
	Paradise	16,830	54,730
	Diamond	26,097	101,633
	Hemlock	15,582	45,860
	Donnell	17,791	59,522
	Stone	18,771	61,864
	Driskel's	12,089	33,158
	Juno	15,430	52,128

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Cass (Continued)	Harwood	15,509	48,268
	Corey	20,832	75,577
	Long	17,270	56,903
Charlevoix	Susan	7,208	21,554
	Six Mile	7,383	23,340
	Dutchman Bay	14,874	64,176
	Thumb	6,747	21,212
	Ironton	13,390	56,723
	Deer	7,661	24,618
Cheboygan	Mullett-N	8,659	35,301
	Cochran	4,058	9,799
	Munro	2,951	8,998
	Silver	4,921	13,254
	Long	10,722	31,426
	Lancaster	1,758	4,299
	Mullett-E	11,553	47,403
Clare	Long	6,294	19,538
	Five	14,637	45,213
	Cranberry	9,019	24,842
	Windover	8,036	21,083
	Crooked	12,122	36,854
	Little Long	7,157	18,059
	Perch	8,036	21,083
	L. George	10,270	29,458
	Nestor	7,288	21,322
	Lilly	11,455	34,120
Clinton	Muskrat	12,539	36,822
Crawford	Horseshoe	3,848	8,862
	Bluegill	3,999	9,329
	Guthrie	5,440	14,126
	Section One	4,156	9,828
	Kyle	3,450	7,687
	K P	5,154	13,174
	Lake Margrethe	15,171	48,870
Emmet	Lake Paradise	3,628	12,012
	Round	8,611	27,477

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Emmet	Pickerel	8,905	30,698
(Continued)	Crooked	10,144	37,865
Genesee	Lobdell	51,790	228,008
	Lake Fenton	83,391	227,680
Gladwin	Pratts	14,013	41,317
	Wiggins	18,035	67,350
	Lake Four	9,862	25,044
	Wixom	23,451	98,665
Grand Traverse	Fish	4,314	11,324
	Silver	9,731	34,285
	Ellis	6,108	17,263
	Cedar	9,585	31,741
	L. Skegemog	12,438	46,065
	Fife	8,836	38,386
	Bass	8,813	29,740
	Green	10,585	38,329
	Cedar Hedge	8,004	25,736
	Bass	5,418	15,211
Hillsdale	Hemlock	12,428	33,417
	Cub	19,859	53,729
	Bear	19,503	52,335
	Bird	19,366	51,803
	Long Lake North	13,761	38,535
	Round	10,621	26,837
	Long Lake South	12,428	33,417
Ionia	Morrison	25,814	86,090
	Long	22,216	76,230
	Woodard	22,541	65,535
Iosco	Floyd	5,662	15,512
	Cedar	7,288	21,322
	Tawas	11,403	43,794
	Londo	7,678	24,374
Isabella	Littlefield Lake	14,872	46,090

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Jackson	Center	49,205	192,300
	Crispell	26,688	83,839
Kalamazoo	Barton	24,671	85,291
	Sherman	49,011	153,520
	Long	38,260	144,917
	Eagle	23,617	84,462
	LeFever	11,003	29,698
	Paw Paw	19,560	62,516
	Rupert	21,061	64,699
	Austin	72,739	236,130
Kalkaska	Blue	5,766	14,881
	Starvation	5,992	15,720
	Bear	7,410	21,069
	Cub	4,824	11,608
	Indian	5,098	12,540
	Big Twin	13,802	45,363
	Cranberry	3,290	7,127
Kent	Murray	22,556	81,062
	Campau	20,322	71,108
	Bass	16,400	52,661
	Camp	19,284	65,919
	Big Pine	20,890	73,210
	Campbell	15,676	50,140
	Lincoln	19,769	67,052
	Lime	10,926	33,440
Lake	Big Star	18,268	59,134
	North	6,202	15,593
	Harper	7,811	21,744
	Switzer	4,184	8,953
	Reed	6,101	15,248
	Paradise	5,879	14,494
Lapeer	L. Nepessing	46,449	192,755
Leelanau	L. Leelanau-W	6,721	27,043
	L. Leelanau-E	12,700	53,484
	Cedar	8,100	29,628
	L. Leelanau-S	6,721	27,044
	L. Leelanau-N	6,721	27,043

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Leelanau (Continued)	Glen	8,697	34,770
	Lime	5,904	20,152
	Armstrong	3,155	8,038
	School	4,531	13,712
Lenawee	Sand	35,239	136,832
	Allens	21,521	67,295
	Devils	41,632	150,272
Livingston	L. Chemung	46,616	204,321
	Crooked	52,891	241,154
	Woodland	54,132	248,440
	Whitmore	48,640	223,526
Manistee	Bear	7,139	258,236
	Portage	7,340	26,898
	Stronach	9,387	32,549
Mason	Gun	6,877	22,831
	Ford	6,656	219,255
	Hackert	6,938	22,006
	Plinness	6,363	19,628
Mecosta	L. Mecosta	13,975	41,734
	Chippewa	29,894	101,410
	Pretty	11,149	30,838
	Townline	12,573	35,723
	Clear	8,072	20,082
	Hillsvie	11,543	32,742
	Brochway	7,172	18,347
	Jehnsn	10,820	30,253
	Lower Evans	18,013	60,524
	Big Evans	18,013	60,524
	Upper Evans	18,013	60,524
	Winchester	18,013	60,524
Missaukee	Bergess	24,068	84,677
	Sapphire	8,416	24,377
Montcalm	L. Montcalm	10,070	27,254
	Crystal	22,154	68,897
	Horseshoe	11,206	31,205

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Montcalm (Continued)	Nevins	12,227	36,218
	Dickerson	17,704	58,096
	Clifford	16,725	54,002
	Derby	14,769	46,050
	Swan	9,515	28,114
	Little Whitefish	16,780	52,909
	Muskellunge	15,636	48,037
	Half Moon	12,012	35,383
	Tamarack	15,469	46,798
	Rainbow	16,445	51,470
	Cowden	15,464	47,330
	Loon	11,410	33,052
Montgomery	Rush	4,423	14,388
	Grass	4,485	14,703
	Crooked	3,111	8,694
	Avalon	4,463	14,587
	Gaylanta	3,764	11,353
	Sage Lake Flooding	3,303	9,446
	Long	4,266	13,616
	DeCheau	2,734	7,276
Newago	Crooked	3,111	8,694
	Brooks	15,963	54,940
	Diamond	13,787	43,920
	Pickerel	16,235	56,296
	Hess	21,024	81,186
	Bills	14,790	49,219
	Englewright	11,133	33,623
Oakland	Robinson	12,950	40,217
	Squaw	39,197	181,027
	Lakeville	47,377	231,404
	L. Orion	47,785	234,720
	Oakland	53,087	255,389
	Loon	53,054	255,182
	Maceday	57,735	284,700
	Crescent	48,849	226,742
	Orchard	115,799	383,160
	Union	58,515	296,276
	Long	49,582	240,157
	Wolverine	14,863	45,249

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Oakland (Continued)	Cedar Island	48,974	236,404
	White	51,351	249,318
	Pontiac Lake N	61,352	307,862
	Big Lake	47,901	219,153
	Tipsico	49,994	226,179
Oceana	Crystal	8,145	23,000
	McLaren	12,418	42,154
Ogemaw	Clear	6,664	19,985
	Hardwood	7,358	22,592
	Sage	10,214	35,826
	Horseshoe	4,581	11,770
	George	7,354	20,174
	Bush	4,881	12,410
	Tee	7,147	19,434
	L. George	6,808	20,558
	Peach	9,099	26,988
	Au Sable	7,484	23,320
	Rifle	6,780	20,446
	Long	6,287	17,891
Osceola	Hicks	8,286	22,172
	McCoy	3,744	8,844
	Wells	5,080	13,311
	Todd	5,684	15,311
	Diamond	5,403	14,395
Oscoda	Tea	4,005	12,398
Otsego	Dixon	7,195	17,855
	Big	7,968	20,600
	Brandford	7,546	20,129
	L. Manuka	6,884	17,732
	Heart	5,616	13,407
	Opal	6,448	16,217
	Big Bass	5,708	13,707
	L. Twenty Seven	7,886	20,297
	Emerald	5,372	12,619
	West Twin	5,996	21,386
Ottawa	Petty's Bayou	3 3,814	143,292

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Presque Isle	Lost	3,567	11,129
	Long	23,132	72,927
	L. Emma	3,921	12,970
	L. Nettie	4,242	14,445
	Little Tomahawk	3,072	7,531
	Grand	11,241	49,236
	L. Ferdelman	2,925	8,187
	Bear Den	3,266	8,196
	Lake May	3,832	12,488
Roscommon	L. St. Helen	114,129	202,290
	Houghton Lake-W	25,492	97,848
	Houghton Lake-E	25,492	97,848
	Higgins Lake-W	33,110	125,860
St. Joseph	Pleasant	27,419	90,159
	Klinger	23,598	84,163
	Fishers	28,446	95,322
	Clear	26,978	87,981
	Fish	19,889	60,066
	Thompson	17,370	49,914
	Palmer	26,855	89,865
	Long	19,147	58,802
	Noah	19,288	53,967
	Lee	12,039	30,496
	Sturgeon	23,743	75,587
Van Buren	Clear	16,915	53,804
	Round	18,708	63,729
	Gravel	23,567	83,844
	Saddle	23,862	86,330
	Cedar	23,138	81,623
	Brandywine	17,383	55,850
	Van Auken	21,674	77,964
	Three Mile	24,067	83,684
	Huzzy	18,015	56,978
	L. Cora	23,634	84,442
	Wolf	18,411	60,325
	L. Eleven	16,116	59,335
	Fish	17,096	54,590
	Scott	18,770	61,924
	Rush	21,512	73,563
	Hall	15,786	46,701

APPENDIX F (Continued)

<u>COUNTY</u>	<u>LAKE</u>	<u>VISITS</u>	<u>CONSUMER SURPLUS</u>
Van Buren	Lake of the Woods	22,917	80,488
(Continued)	Shafer	20,062	66,376
	Eagle	21,483	73,350
	Reynolds	20,374	67,898
	School Section	19,844	63,559
	L. Fourteen	16,915	53,804
	Three Legged	13,763	40,508
	Jeptha	15,967	49,701
	Bankson	21,866	75,223
Wexford	Berry	7,927	21,126