PREDICTING USE LEVELS FOR MICHIGAN'S INLAND LAKE PUBLIC ACCESS SITES: A MULTIPLE REGRESSION APPROACH WITH AN EMPHASIS ON SITE ATTRACTIVENESS

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ABSTRACT

PREDICTING USE LEVELS FOR MICHIGAN'S INLAND LAKE PUBLIC ACCESS SITES: A MULTIPLE REGRESSION APPROACH WITH AN EMPHASIS ON SITE ATTRACTIVENESS

By

James Philip Sluyter

Recreational boating is an increasingly popular activity in Michigan. In order to provide boating access to Michigan's lakes and streams the Waterways Division of the Department of Natural Resources (DNR) is continuing to aquire and develop public access sites. The Waterways Division has identified a need for a more efficient allocation of resources in the development of sites.

In order to have at its disposal a more objective site selection criterion than was available, the Waterways Division contracted with Michigan State University Department of Park and Recreation Resources to develop a model for estimating dollar benefits which accrue to the users of public access sites. The study was designed to provide a method for estimating usage at proposed sites and assign a dollar value to that usage by developing demand curves for the sites. The study, completed in 1976 by Thomas D. Warner, utilized data gathered from 16 public access sites in Michigan's Lower

Peninsula. The model developed by Warner was found not to be effective in predicting individual site usage.

The objective of the study reported herein is to develop a model, based on Warner's efforts, which would accurately predict use of specific proposed public access sites. This revised model, developed through multiple regression techniques, took the following form:

$$Y_{ij} = 10^{C}\ P_i^{B_1}\ d_{ij}^{B_2}\ A_j^{B_3}\ C_j^{B_4}\ S_j^{B_5}$$

Y_{ij} = number of vehicle entries from origin zone "i" to destination public access site "j."

C = constant.

B_1-B_5 = regression coefficients to be estimated.

P_i = population of origin zone "i."

d_{ij} = travel time from zone "i" to site "j."

A_j = attractiveness of site "j."

C_j = accessibility of site "j."

S_j = surface acreage of lake at site "j."

The sum of Y_{ij} values (one for each origin zone used in analysis) would be the prediction of usage for the period of time in which surveys were taken on the sites by Warner. "Expansion factors" are used to derive annual predictions.

The following changes were made to Warner's model in this study:

1. Visitor origin data were classified by "concentric time zones" around each site rather than by a system of 508 "time zones" utilized by Warner.

2. Separate models were developed for predicting usage by boating users and non-boating users.

3. Two variables used in Warner's model--Median Family Income and Gravity (a measure of competing opportunities)--were not used in the revised model due to their lack of statistical significance in Warner's model.

4. Two variables--Attractiveness and Accessibility--were added to the revised model in an attempt to improve individual site predictions. The Attractiveness and Accessibility Variables were formulated by the "professional judgment" method.

It was found that separate equations for DNR Regions II and III were more accurate in predicting usage, based on vehicle counters installed at the sites studied. The use of separate models for boaters and non-boating users was less accurate than a "total visit" model which combined boaters and non-boaters. The revised model ("total visit regional model") was found to be more accurate than Warner's in predicting access site usage. The Attractiveness and Accessibility Variables were found to be statistically significant only in the Region II equation.

Though considerable differences between predicted use levels and counter data at some sites remain, the ability of the model to predict relative use levels is considerably improved over the Warner model.

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CHAPTER I

INTRODUCTION AND RESEARCH PROBLEM

Introduction

Michigan has enjoyed a long-standing and well deserved reputation for being a "water wonderland." Michigan's key position in the Great Lakes region is largely responsible for this. Of more interest to this study, however, is the wealth of inland bodies of water, including approximately 5,500 inland lakes of 10 acres or more. It is not surprising that recreational boating has become a popular recreation activity in the state.

The title to all bodies of water in the state is held in a trust for the public by the State of Michigan. All that is needed to make a lake public is to provide legal access to that lake.

Provision of public access to lakes and streams began in 1939 with the provision of "walk-in" sites for fishermen, funded through increases in the fishing license fee. With the increasing popularity of boating following World War II, these sites began to see more and more use as boating access points. At first, most of the boats were small, car-top craft, and the existing sites with limited facilities were adequate. As the popularity of boating continued to increase so did the pressure on the sites. In addition, larger boats requiring trailers were becoming common. These boats require facilities such as ramps and expanded parking areas not envisaged in the original Public Access Program. To more adequately meet this need, the Public Access Program was transferred to the Michigan State Waterways Division in 1968. Allocations from the State's marine fuel tax and boater registration fees provide most of the funding for the program.

At the present there are over 600 public access sites under Waterways Division administration statewide, with over 60% of them on inland lakes. Acquisition and development continues, however, in order to meet the demand represented by nearly 700,000 boats in the state. The need for efficient allocation of resources was made explicit in a 1972 statement of acquisition criteria which expressed the need to "provide for the greatest number of recreational opportunities for the fewest dollars expended."[1]

In order to have at its disposal a more objective site selection criterion than was available, the Waterways Division contracted with Michigan State University Department of Park and Recreation Resources to develop a model for determining dollar benefits which accrue to the users of public access sites. The study was designed to provide a

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

method for estimating usage at proposed sites and assign a dollar value to that usage by developing demand curves for the sites. "Through the development of the site visitation and demand estimation model, the Waterways Division will 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.' "[2] This study was carried out in 1975 by Thomas D. Warner. It will be discussed in some detail in Chapter II (Literature Review) of this paper.

Problem Statement

As indicated above, a site visitation and user benefit model has been formulated. Warner reports, however, that

> None of the models discussed appears to be a reliable predictor for individual lake visitations 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...is that of adding a site attractivity variable to the model. [3]

In spite of the problems encountered in applying the model to specific sites, Warner reports that aggregate estimations seemed valid, based on a small number of sites used to test the model's accuracy. The accuracy of site specific visitation prediction is critical to the development of benefit estimations, and thus to the selection of sites for development. It was felt that refinements could be made to

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[2]Thomas D. Warner. An Estimation of User Benefits Associated with the Michigan Public Access Program for Inland Lakes. (Michigan State University: Ph.D. Dissertation, 1976), p. 5.

[3]Ibid., p. 103.

the model which would enable the Waterways Division to use it for site selection purposes.

Objective of the Study

The model developed by Warner, as mentioned above, did not fully explain observed variation in individual public access site usage. Some of the results, however, were encouraging enough to suggest that work toward refining Warner's model would be beneficial. The basic objective of this study is to develop a model, based on Warner's efforts, which would accurately predict use of specific proposed public access sites.

CHAPTER II

LITERATURE REVIEW AND RESEARCH HYPOTHESIS

This chapter is divided into five parts: 1) a look at gravity models and some previous efforts at estimating recreation site use; 2) a summary of the site visitation model developed by Warner and some comments on refinements which seem appropriate; 3) a discussion of visitation estimation efforts which have included an attractiveness component in the analysis; 4) a summary of a study of attractiveness which was carried out on the same public access sites as those used by Warner; 5) a statement of the research hypothesis and a number of sub-hypotheses.

Estimation of Site Use

The gravity model[4] has become a very popular technique in the analysis of recreation site visitation. "The intuitive simplicity and relatively good predictive power of the gravity model have made it one of the most widely used interactance models."[5] The basic form of the gravity model

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[4]Gravity models were formulated by Stewart (1941) based on the social gravity concept advanced by Carey (1858).

[5]John H. Ross. A Measure of Site Attraction. (Lands Directorate: Environment Canada, Ottawa, 1973), p. 3.

is:

$$I_{ij} = \frac{GP_iP_j}{D_{ij}x}$$

I_{ij} = a measure of interaction between points i and j

P_iP_j = populations of i and j

D_{ij} = measure of distance between i and j

G and x = constants to be fitted

When using gravity models to predict visitor flows from an origin point to a destination site, one of the population measures is often transformed into some form of measure of attraction of the destination site.

Brown and Hansen[6] used a gravity model in their analysis of recreational use of seven reservoirs in California. Interviews with visitors were conducted over a period of four years. Visitor origin data were classified by county units and parts of counties. Road mileage, population, size of the reservoir, and a measure of alternative recreational opportunities were the independent variables used to explain observed differences in the number of visitors to the reservoirs.

An equation was estimated using multiple regression methods on the basis of observed visit patterns. All variables were significant at the .01 level and the equation

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[6]R.E. Brown and W.J. Hansen. "A Generalized Recreation Day Use Planning Model, Plan Formulation and Evaluation Studies-Recreation." Technical Report 5. (U.S. Army Corps of Engineers: Sacramento, California, 1974).

accounted for approximately 92% of the variation in visitor numbers.

An earlier study of reservoirs in Texas[7] utilizes the same basic model. Counties within a 100 mile radius of each of eight reservoirs in the study were used to classify visitor origin data. The independent variables used to explain observed use were: origin county population; average per capita income, origin county; proximity of the origin county to the reservoir, measured in terms of round trip travel costs; a measure of alternative water sites within 100 miles of origin county; and the size of the reservoir. The equation used was exponential, determined through least square regression analysis. All variables were significant at the 5% level, and the equation accounted for 41% of the observed variation. The Texas Study went on from visitation estimation to the development of demand curves for each reservoir which could be used to place a dollar value on the sites.[8] The model was used to calculate visitations to and dollar benefits associated with proposed reservoirs. The Texas Water Plan Study is the basis of Warner's efforts at estimating user benefits in the Michigan Public Access Site Program.

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[7]Herbert W. Grubb and James T. Goodwin. "Economic Evaluation of Water-oriented Recreation in the Preliminary Texas Water Plan" (Texas Water Development Board: Austin, Texas, 1968).

[8]Development of demand curves for recreation areas will not be covered in this paper. Readers interested in pursuing this subject are encouraged to consult the Texas Study or Clawson and Knetsch (1966).

Michigan Public Access Site User Benefit Research

The research upon which this study is based, completed in 1976 by Thomas D. Warner, involved the estimation of dollar benefits attributable to the Michigan inland lake public access system in the Lower Peninsula. The study was completed for the Michigan State Waterways Division, to be used as a tool for selecting among alternative sites for development, and only sites administered by that agency are included in the research model. The first step in generating user benefits attributable to proposed sites is the development of a model for predicting site usage and travel patterns--i.e. distribution of origin points. Data gathered by personal interviews of site users at 16 "survey sites" in the summer of 1975 were used to develop a series of site specific visitation equations.

The model was developed along the lines of the Texas Water Plan (described in the last section). Visitor origin data, however, were classified differently. Instead of distributing users into counties, Warner used the "time zone" system developed by the Michigan Department of Transportation.[9] Under this system the 83 counties in Michigan are broken down into 508 individual "Time Zones" (see figure 1). It was felt that predictive accuracy under this system would be greater than that of the Texas Water Plan, since data in these smaller areal units would more accurately reflect the characteristics of the residents. The

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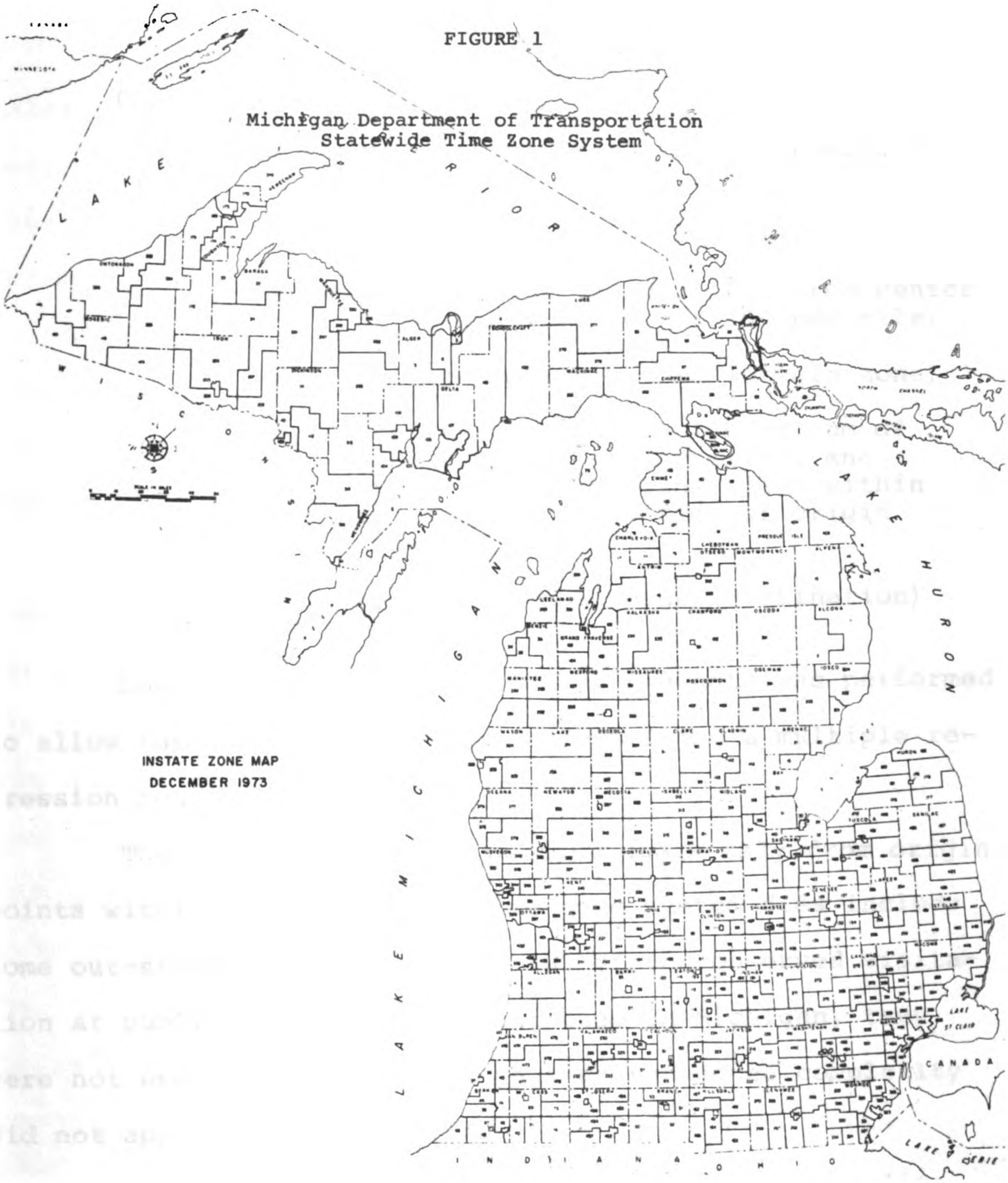
[9]Michigan Department of State Highways Statewide Transportation Analysis Research (Lansing, Michigan, 1973).

FIGURE 1

Michigan Department of Transportation
Statewide Time Zone System



dependent variables for the study were selected and defined on the basis of the data included in the time zone system. The model was defined as follows:

$$(Y_i + 1.0) = ax_1^{B_1} x_2^{B_2} x_3^{B_3} x_4^{B_4} x_5^{B_5}$$

Y = number of visitors to access site i (from origin time zone)

X_1 = time zone population (origin)

X_2 = travel costs (2x distance from center of origin time zone x 20¢ per mile)

X_3 = average family income (origin zone)

X_4 = gravity variable (weighted sum of lake acreage, stream miles, and Great Lakes shoreline miles within two hours driving time of origin zone)

X_5 = surface lake acreage (destination)

Logarithmic transformation of the data was performed to allow for analysis in a linear form using a multiple regression routine.

The model was used to predict usage only from origin points within Michigan. The time zone system does include some out-state areas, but since 98% of the observed visitation at public access sites originates in Michigan, they were not used in the analysis because the added complexity did not appear to be justified.

In discussing the relative difficulty of modeling visitation rates in Michigan, Warner notes that

> The model used to predict visitations to Michigan public access sites, unlike the Texas Water 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 Parkland.[10]

Warner selected 16 of the 35 public access sites on inland lakes in Michigan Department of Natural Resources (DNR) Regions II and III on which the Waterways Division maintains electronic vehicle counters. Interviews with users at these "survey sites" resulted in 2,601 cases which could be used for data analysis. The survey sites were selected to reflect a broad range of: 1) lake acreage; 2) proximity to population centers; 3) availability of alternate water bodies. Figure 2 shows the location of the 16 survey sites.

A multiple regression computer routine written under the Statistical Package for Social Sciences (SPSS) was applied to the data. This resulted in a set of coefficients for use in the site visitation equations. Another computer program applied the equation to each of the 508 time zones in Michigan to predict usage to a given site from each zone. The sum of the zone visitations would be the predicted usage for the site for the time period of the survey. This, multiplied by a constant "expansion factor" yielded predicted annual vehicle entries; another expansion factor reflected average number in a party and provided total annual visitors. The final step was the creation of demand curves and estimated dollar benefits based on

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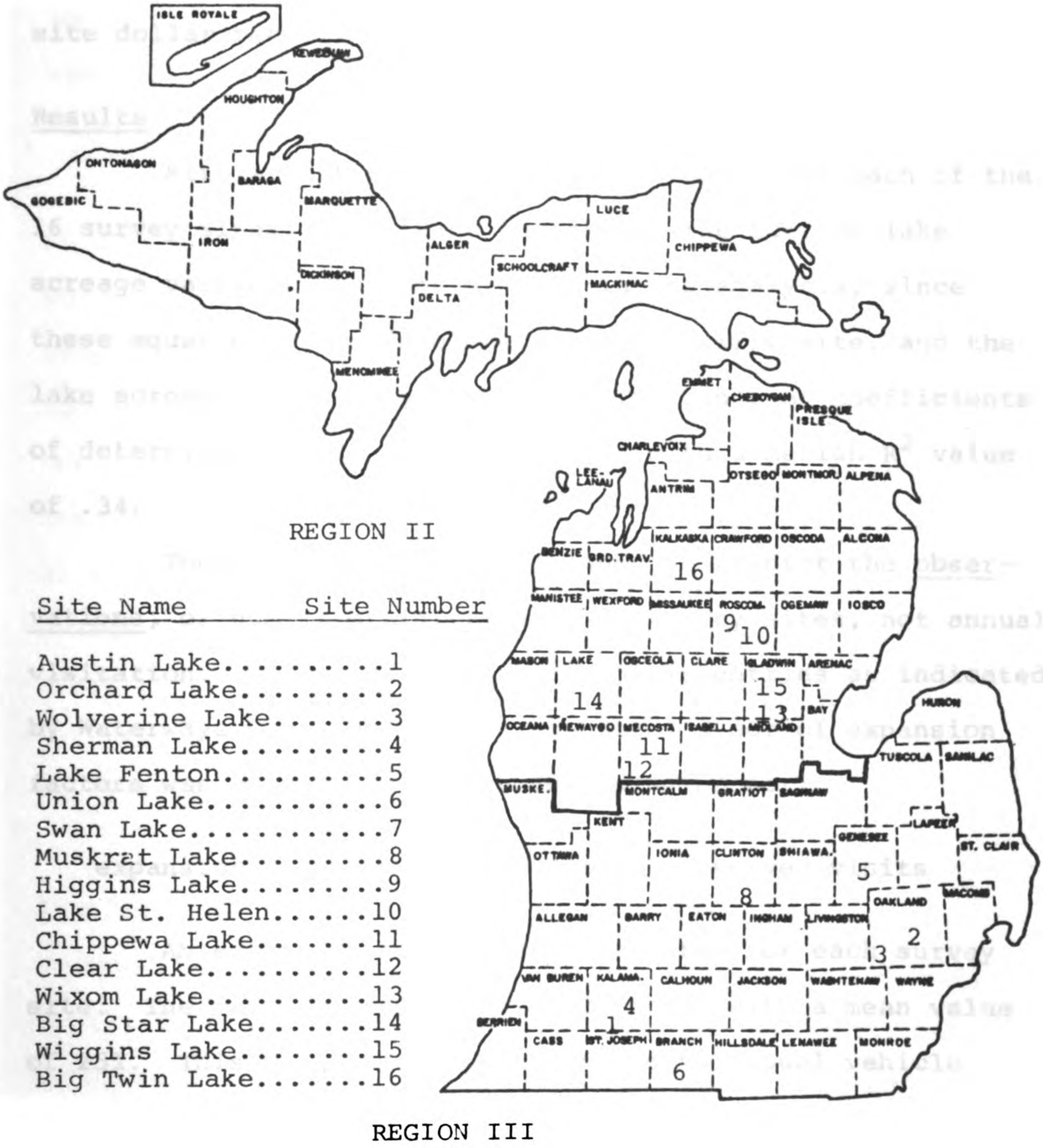
[10]Warner, op. cit., p. 27.

Figure 2

Waterways Division Access Sites Selected for Visitation Survey



Site Name	Site Number
Austin Lake	1
Orchard Lake	2
Wolverine Lake	3
Sherman Lake	4
Lake Fenton	5
Union Lake	6
Swan Lake	7
Muskrat Lake	8
Higgins Lake	9
Lake St. Helen	10
Chippewa Lake	11
Clear Lake	12
Wixom Lake	13
Big Star Lake	14
Wiggins Lake	15
Big Twin Lake	16

visitation levels and origin points using consumer surplus as a measure of benefits. The accurate prediction of visitations and travel patterns is essential to the accurate estimation of site benefits. Warner notes that "...if the estimated visitation figure is inaccurate, so will be the site dollar benefit estimation."[11]

Results

Site specific equations were created for each of the 16 survey sites. For these equations, the surface lake acreage variable was not included in the analysis, since these equations were developed for a specific site, and the lake acreage would be a constant. The range of coefficients of determination (R^2) was .03 to .62 with a median R^2 value of .34.

These equations were designed to predict the observations, or number of interviews, at survey sites, not annual visitation. To expand to annual vehicle entries as indicated by Waterways Division vehicle counters, a set of expansion factors was calculated in the following manner:

expansion factor = counter total ÷ observed visits

An expansion factor was calculated for each survey site. The range of values was 103 to 639 with a mean value of 251. This value was used to expand to annual vehicle entries. The wide range of expansion factors may be

[11]Ibid., p. 51.

attributable to the small size of the sample, differences among lakes in "after hours" use not reflected in the survey data, malfunctioning vehicle counters, or the counting of vehicles not interviewed (e.g. maintenance). A second expansion factor was used to expand vehicle entries to total visitation. It was found that the average party size was 3.1; this value became the second expansion factor in Warner's study.

In order to develop a best model or models which could be used to predict usage at proposed sites, the data for the survey sites were used to fit several model forms varying by geographical region as follows: 1) all survey site data were aggregated into an all-sites-summed model (a model for the entire region under study); 2) separate equations were formulated for DNR Regions II and III in a regional model; 3) a subregional model was created by separating lakes in the eastern half of Region III from those in the western half and those above and below 1,000 acres in size in Region II resulting in four separate models. Table 1 shows the R^2 values for all the models.

To test the models' effectiveness in accurately predicting site visitation, four sites, again with vehicle counters installed, were selected (See Figure 3). If the models could accurately predict counter observations, application to specific proposed sites could proceed with some confidence. The "test sites" were selected to reflect a range of acreage and regional distribution. Table 2 shows the results Warner obtained.

Table 1

R^2 Values for Site Visitation Models-Warner

Model	Coefficient of Determination (R^2)
All lakes summed	.27
Regional	
Region II	.28
Region III	.37
Subregional	
Region II, 1,000 acre +	.34
Region II, less than 1,000 acre	.26
Region III, East	.39
Region III, West	.34

Table 2

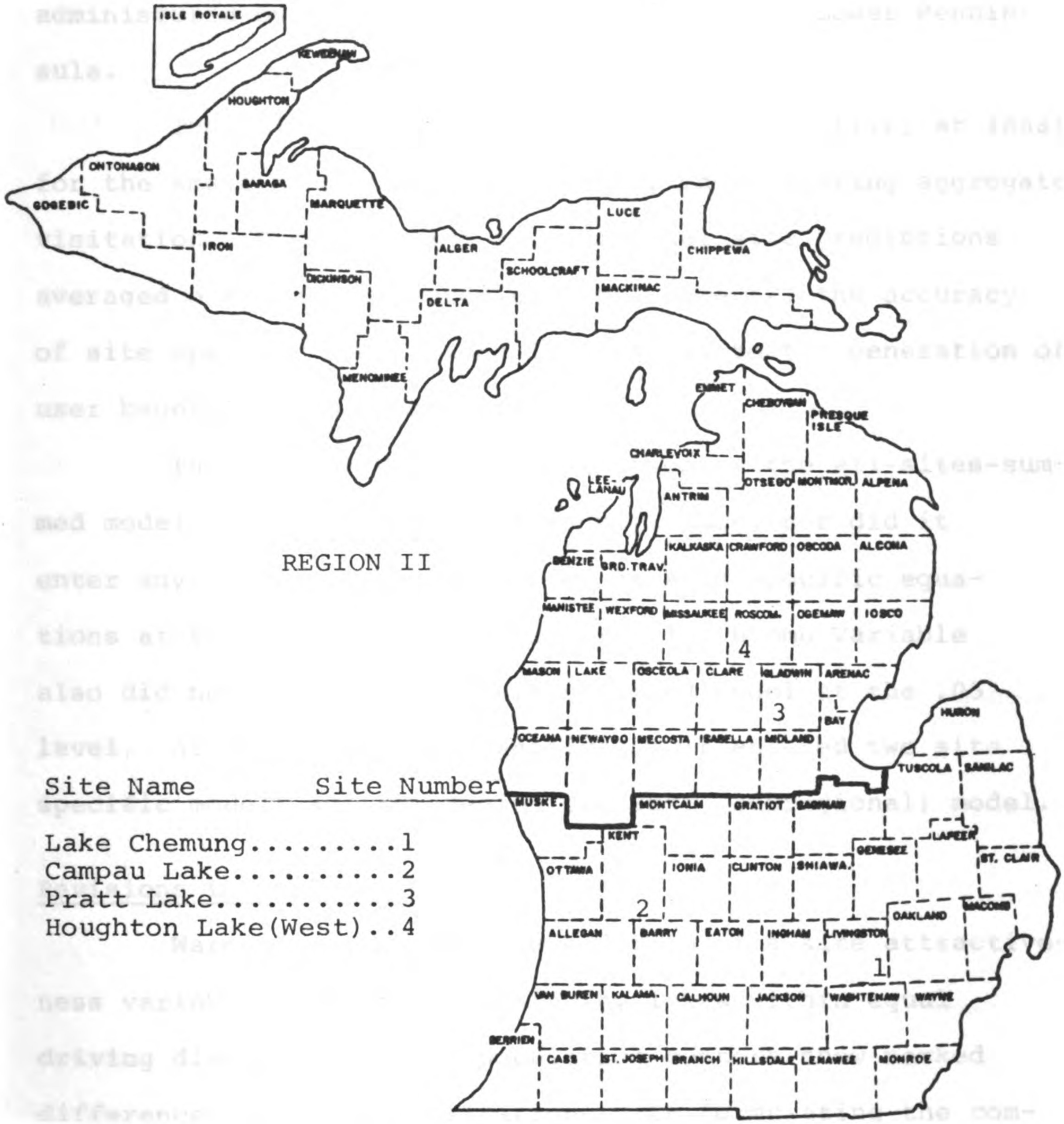
Warner Site Visitation Models:
Test Results*

Lake Site Region III	Counter Data	All Sites Model	Regional Model	Sub-Regional Model
Lake Chemung	24,353	46,616	38,547	(E) 31,777
Campau Lake	40,621	20,322	18,293	(W) 23,273
Totals	64,974	66,938	56,840	55,050
Lake Site Region II	**Counter Data**	**All Sites Model**	**Regional Model**	**Lake Acreage Break-Down (1000</1000>)**
Houghton Lake (West)	32,601	25,492	52,271	65,049 (1000+acres)
Pratt Lake	13,977	14,013	39,035	32,670 (<1000 acres)
Totals	46,578	39,505	91,306	97,719

*This table was taken from Warner, p. 102.

Figure 3

Waterways Division Access Sites Selected to Test the Warner Site Visitation Model



Site Name	Site Number
Lake Chemung	1
Campau Lake	2
Pratt Lake	3
Houghton Lake (West)	4

The most accurate prediction model in Region III was the subregional model; in Region II the all-sites-summed model was most effective in predicting visitation. The all-sites-summed model was selected for use in generating user benefit estimations for all existing public access sites administered by the Waterways Division in the Lower Penninsula.

The all-sites-summed model seemed effective, at least for the small number of lakes tested, in estimating aggregate visitation. Discrepancies in individual site predictions averaged out. As indicated earlier, however, the accuracy of site specific predictions is critical to the generation of user benefits at proposed sites.

The Gravity Variable did not enter the all-sites-summed model at the .05 level of significance, nor did it enter any of the other aggregated or site specific equations at that level. The Median Family Income Variable also did not enter the all sites summed model at the .05 level. At this level of significance it entered two site specific models and the Region III East (subregional) model.

Revisions to Warner's Model

Warner recommended the addition of a site attractiveness variable to better explain why lakes within equal driving distance of major population centers show marked differences in annual visitations. In formulating the components of attractiveness, it was decided that site accessibility should be added to the model as a separate variable.

Early in this study a closer look at the data base used to generate Warner's models prompted a re-evaluation of the "time zone" system for distribution of visitor origin data. With just over 2600 observations distributed over 508 zones (an average of just 5 in each zone) it was felt that there were not enough observations in each zone to justify the use of that system. This will be discussed in greater detail in Chapter III (Research Methodology).

Because of lack of statistical significance of the Gravity and Median Family Income Variables it was decided that they should be dropped from future analysis.

A significant amount of non-boating use of the sites was observed. It seems reasonable to expect that differences in travel patterns and perception of site attractiveness may exist between these two types of users. (i.e. boating and non-boating). Therefore, separate models for boaters and non-boaters were developed.

The study reported herein has incorporated the above revisions to produce a new set of visitation equations. The chapter on Research Methodology explains each revision to the Warner model in greater detail.

Attractiveness as a Component of Site Use

Many researchers have incorporated attractiveness measures in their analysis of site use. In the following paragraphs some of these studies are summarized.

As a part of the "Michigan Outdoor Recreation Demand Study"[12] an attractiveness index for camping areas in Michigan State Parks was formulated. It was an activity oriented index based on three broad categories: 1) outdoor activity preferences of campers; 2) unique physical environmental resources of the park considered to be important to campers; and 3) physical facilities and services that enhance the camping experience and the associated outdoor activities. A total of 72 natural-cultural, facility and service, and activity variables were inventoried and scaled numerically for each park. These were reduced to 55 on the basis of combined professional judgments. Factor analysis was used to test the hypothesis that a large number of variables related to camping in a park can be combined into a relatively few explanatory factors. While the hypothesis was found to be untenable (56% of the variation in data could be explained), its use in a prediction model for camping at Michigan State Parks resulted in much better performance of the model "than with merely some number--such as the number of campsites or acres in the park..."[13] It was concluded that, with respect to aggregate behavior, attraction can be quantified with some degree of success.

In 1966 Cesario developed a model for estimating visitations to existing and proposed recreation sites in

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[12]David N. Milstein, Leslie M. Reid. "Michigan Outdoor Recreation Demand Study, Volume I, Methods and Models". Technical Report #6. (Michigan Department of Commerce: Lansing, Michigan, 1966).

[13]Ibid., p. 66.

the Susquehanna River Basin.[14] Cesario felt that the major factors affecting the use of recreation sites were: accessibility (measured in terms of population centers and distance), competing opportunities, saturation, and attractiveness. Attractiveness was defined using total park acres, the square root of water acres (as a rough proxy for shoreline), and a weighted activities index. In the activities component weights were assigned to account for variation in the numbers of people attracted by different activities in the following order: swimming, picnicking, camping, fishing, and boating. Cesario notes that the major factors affecting demand for a recreation site must be treated as interacting; a multiplicative model is used to account for interaction among variables. The variables found to be significant in explaining variation in site use were population, total acres, and water acres. The availability of activities was found to influence use at certain sites.

In an updated model, Cesario used park attractiveness, population center "emissiveness", and the effect of distance to explain camping visitation to parks in Ontario.[15] The components of attraction used in this study included park acres, the number of camping units, length of swimming beach, acres

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[14] F. J. Cesario. "Appendix Q, Recreation, "Final Report on a Dynamic Model of the Economy of the Susquehanna River Basin. (Battelle Memorial Institute: Columbus, Ohio, 1966).

[15] F. J. Cesario. "Final Report on Estimating Park Attractiveness, Population Center Emissiveness, and the Effect of Distance in Outdoor Recreation Travel", Cord Technical Note #4. (Parks Canada: Ottawa, Ontario, 1973).

of picnic area, miles of hiking trails, boating facilities, availability of trailer sanitary stations, and availability of showers. Of 12 park characteristics, the most influential camping attractions were found to be: the size of the park, the size of the campground, and the length of the beach.

Seneca and Cichetti developed a model for analyzing visits at a site using land acres, water acres, parking places, availability of swimming, and fee charged.[16] A linear logarithmic equation was used. The importance of water acres was found to be twice that of land acres in explaining variation in visits. Availability of swimming was found to be an important determinant of site use, and the parking space variable was significant. The positive effect of fees "implies that the fee variable acts as a proxy for the availability of additional, necessary user facilities that usually are associated with fee charges (e.g. boat facilities, campsites, miscellaneous services)."[17]

In 1971, in a study of Michigan State Park campgrounds, Hodgson hypothesized that more attractive campgrounds (those with larger average lengths of stay) would offer a greater number of activity opportunities, a greater number of services, and a higher activity potential of

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[16]Joseph J. Seneca, Charles J. Cichetti. "User Response in Outdoor Recreation: A Production Analysis". Journal of Leisure Research. 1, 3 (Summer, 1969).

[17]Ibid., p. 242.

adjacent waters than less attractive campgrounds.[18] Only the activity potential of adjacent waters was found to be significant. This variable was defined in terms of beach type, the body of water (Great Lake, inland lake, stream), and water clarity.

Day use visitation patterns to 11 Provincial and one National Park in Saskatchewan were studied by Cheung.[19] The units of analysis of visitor origin data for a particular park varied from 13 to 24. The independent variables used were origin population, accessibility (defined as distance), alternative recreation opportunities, and park attractiveness. The index of attractiveness was calculated for each of the 12 parks on the basis a relative popularity rating of activities (as determined by separate national surveys), the relative importance of facilities at each park for drawing visitors, and a measure of the quantity or quality of the facilities provided at each park. A linear equation was developed through stepwise multiple regression techniques. The population variable entered the equation first, and explained 84% of the variation. While all variables were significant in the equation at the 1% level, attractiveness entered with a very low R^2 value. Cheung suggests that the low value is more likely a result of an error in the

[18] Ronald Wayne Hodgson. Campground Features Attractive to Michigan State Campers. (Master's Thesis, Department of Resource Development: Michigan State University, East Lansing, Michigan, 1971).

[19] Hym Cheung. "A Day-Use Park Visitation Model", Journal of Leisure Research, 4 (Spring, 1972).

functional form of the equation than the basic unsoundness of the attractiveness variable.[20]

A behavioral approach to attractiveness was taken by Ross.[21] Attractiveness was defined in terms of users' willingness to travel to a park more distant than an alternative. Users will tend to "skip over" less attractive parks to go to those considered more attractive. The methodology was applied to picnic sites and day use parks. The results of the analysis were encouraging in that it appears that "the determination of attraction scales which are highly consistent with observed spatial behavior patterns is possible through the use of the proposed methodology".[22]

On a more theoretical level, Levine et. al. have developed a set of "interest intensity" curves to conceptualize the perception of various environmental factors by users.[23] Figure 4 illustrates the curves. It is assumed that a finite number of environmental characteristics determine a group's interest in an activity at a given location, and that these form a "conceptual bundle" of characteristics which relate to the activity. It is also assumed that all variables are not equal in determining the attraction of a specific location.

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[20] Ibid., p. 152.

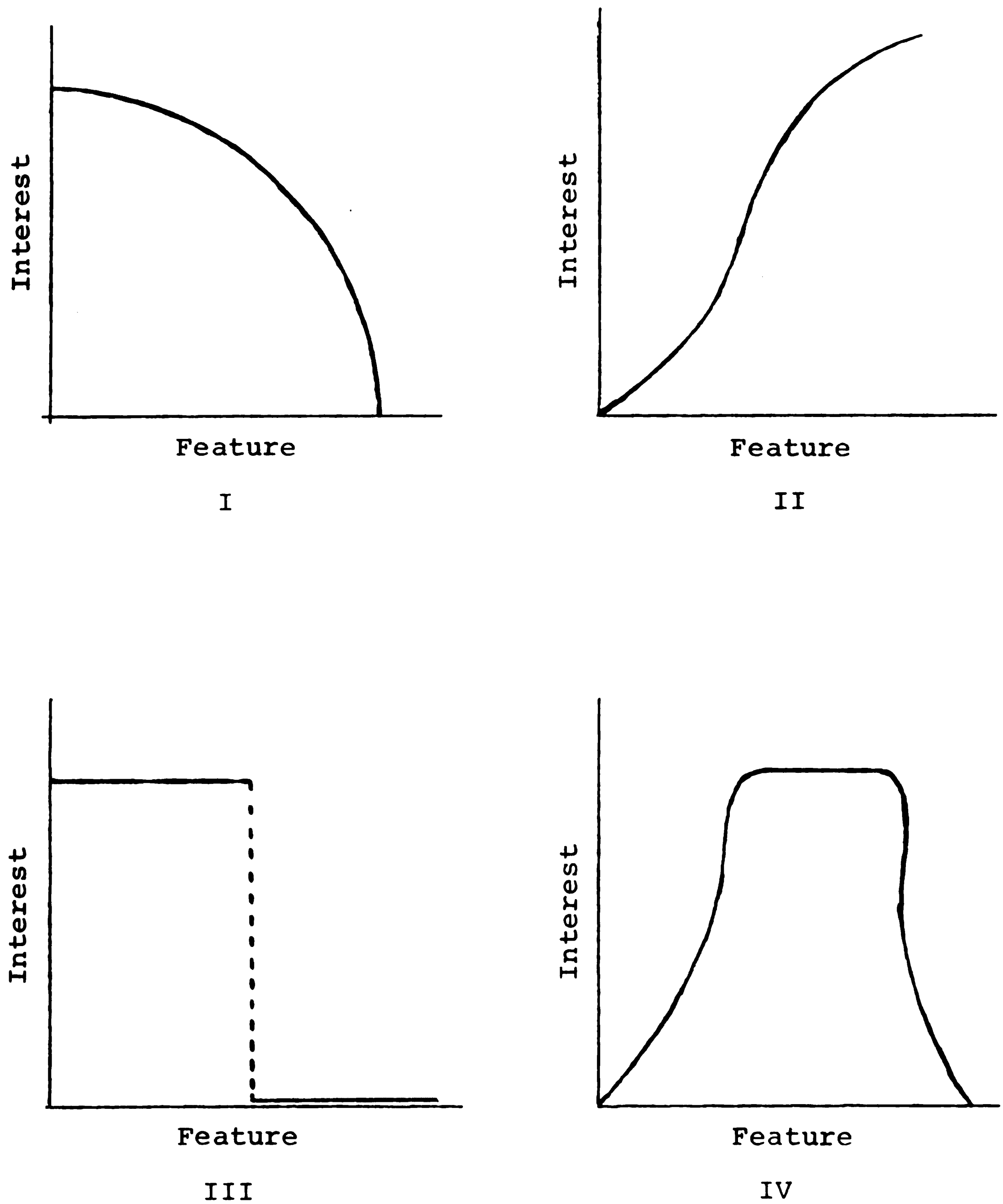
[21] Ross, op. cit.

[22] Ibid., p. 110.

[23] Ralph L. Levine, Robert H. Boling, Gary K. Higgs, "Toward Understanding the Role of Environmental Variables on Attractivity and Recreational Choice: A Model for Evaluating Activity Bundles", unpublished paper.

Figure 4

Hypothetical Responses to
Environmental Features



The first curve (Type 1) relates to the perception of an undesirable feature. Interest in swimming, for example, might be described by this curve if the feature under examination is the number of dead fish on the beach or the turbidity of the water.

A Type II curve describes the effect of desirable features; with regard to swimming, variation in sand cleanliness might produce such an interest curve.

The Type III curve shows the effect of some feature which will cause an abrupt change from full to no interest at some threshold. It describes the effect of failing to provide a feature considered absolutely necessary to the user.

A Type IV curve describes a feature which will cause an increase in interest in the activity as the feature intensity is increased up to a point, then a decrease in interest. It might describe the effect of the number of persons on a beach--as some point of saturation is reached, interest drops off.

Characteristics of Public Access Sites Important To Users

Concurrent with Warner's User Benefit Study, and using the same 16 survey sites, several "subprojects" were completed. One of these, designed by Govoni, was an investigation of the characteristics of public access sites which users felt were important in selecting a site.[24] Users were interviewed at the site. A total of 335 interviews was used in the analysis. Respondents were asked to rate from 1 (not important) to 5 (very important) a list of site characteristics in terms of their importance in selecting any public access site. These characteristics were divided into the following headings: 1) water characteristics, 2) natural land characteristics, 3) shoreline characteristics, 4) facilities, and 5) locational characteristics. Mean ratings were calculated for each of five primary activity groupings: pleasure boaters, fishermen, water skiiers, swimmers, and sightseers.

Those variables which had potential for inclusion in this study and their mean ratings are shown in Table 3.

Govoni reports that the study indicated that "other site characteristics besides water attract the visitor to the site, including such things as scenery around the lake... presence of sandy beaches...and ease of finding site."[25]

Govoni's study was not conducted in such a way that the findings could be directly translated into a measure of site attractiveness for use in the visitation model. It does offer considerable direction in the selection and weighting of

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[24]Leonard Govoni, "A Study of What Attracts Pleasure Boaters, Fishermen, Waterskiiers, Swimmers, and Sightseers to Michigan Inland Lake Public Access Sites Under the Jurisdiction of Waterways Division of the Michigan DNR." Technical Paper. (Michigan State University, 1976).

[25]Ibid., p. 43.

Table 3

Mean Ratings for Selected Site Characteristics*

Site Characteristic	Pleasure Boaters	Fishermen	Water-skiiers	Swimmers	Sight-seers
Clearness of water	3.90**	4.03	3.72	4.41	4.15
Lack of underwater growth	4.13	4.31	4.10	4.61	4.46
Deciduous trees	2.89	2.64	2.77	2.77	3.31
Evergreen trees	2.68	2.52	2.72	2.52	3.27
Scenery around lake	3.77	3.71	3.84	3.86	4.44
Lack of shoreline development	2.55	2.99	2.98	3.36	3.98
Ability to dock boat along shore	3.99	3.86	4.36	3.12	3.60
Presence of rocky shoreline	3.05	2.77	3.00	2.71	2.77
Presence of marshes	2.73	2.98	2.72	2.60	2.60
Presence of sandy beaches	4.13	3.59	4.32	4.63	4.13
Ramp type	4.32	4.09	4.43	2.91	3.48
Toilet facilities	4.09	4.32	4.21	4.32	4.29
Docking facilities at ramp	3.66	3.39	3.52	2.87	3.04
Nearness to major roads	3.27	3.04	2.93	3.06	3.90
Ease of finding site	4.00	3.75	3.40	3.85	3.90

**Sites were rated from 1 (not important) to 5 (very important)

*This Table was taken from Govoni, p. 27.

the components of the attractiveness variable. This will be covered in greater detail in the next chapter.

Research Hypothesis

The objective of this study, as stated earlier, is to develop a model which will more accurately predict site specific visitation levels at Michigan inland lake public access sites than is possible with Warner's model. This was undertaken through the addition of new variables and modification of the model. Following Warner's recommendation, a site attractiveness variable was formulated and added to the model. In the process of formulating a measure of attractiveness, it was decided that one component of attractiveness, ease of access to the site, would be separated and added to the model as a separate variable.

Early in the study it was decided that the "time zone" format for visitor origin data would be revised. The time zones were aggregated into concentric bands or zones around each site.

In an attempt to make the model more sensitive to different types of users, separate models were developed for boaters and nonboaters, as well as "total visit" models where both groups are combined.

Finally, two variables were dropped from Warner's model--gravity (competing recreation opportunities) and median family income--due to their insignificance in Warner's models.

These changes will be discussed in greater detail in the following chapter.

The primary hypothesis of this study is:

Study Hypothesis: The addition of two variables--Site Attractiveness and Accessibility--and the aggregation of "time zone" data into concentric zones will significantly improve the predictive accuracy of the site visitation model developed by Warner.

A series of sub-hypotheses will also be analyzed which relate to the independent variables used in the study as well as the change in the dependent variable (boater and non-boater distinction).

Sub-Hypothesis #1: Separate models for boaters and non-boating users will be more effective in predicting site visitation than a single "total visit" model which combines all boaters and non-boaters.

Sub-Hypothesis #2: The Site Attractiveness Variable will enter significantly into the prediction equation and will be positively correlated with use.

Sub-Hypothesis #3: The Accessibility Variable will enter significantly into the prediction equation and will be positively correlated with use.

Sub-Hypothesis #4: Visitations to Michigan public access sites are significantly and negatively correlated with the Travel Time Variable.

Sub-Hypothesis #5: The Lake Acreage Variable will have a statistically significant positive effect on site use.

Sub-Hypothesis #6: The population of the origin concentric zone will have a statistically significant positive effect on site use.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

This chapter is divided into six sections. In the first, the formulation of the attractiveness index is discussed. This includes a discussion of some alternative methods for creating the index, the method selected, and some assumptions and problems associated with the method. The first section also presents the components included in the index and general comments on data collection. The second section will present the definition, scoring, and weighting proceedures used in the study. In the third section the formulation of the accessibility variable is described. In the fourth section the variables dropped from the Warner model will be discussed. The fifth section is a description of the aggregation of "time zones" into concentric zones for the tabulation of visitor origin data. The sixth section will present a description of the revised model which is used to predict public access site visitation, and the multiple regression analysis proceedures.

Before proceeding, however, some comments on the concept of attractiveness are appropriate. In the Literature

Review, a number of attractiveness indices were described. Many approaches have been taken to the measurement of attractiveness. But they all have in common the concept that some recreation sites or areas are considered "better" than others by users. Some researchers attempt to quantify those features considered attractive by users while others observe behavior and assume that, other things being equal, a more attractive site will receive more visitation. In this study, the former approach is taken. Attractiveness is defined as a set of characteristics associated with public access sites which influences the choices users make in selecting one site over another. Some characteristics may influence use more through the lack of a feature which would discourage use than through their attractive power. Included in the set of characteristics are: 1) physical characteristics of the site; 2) the "activity potential" of the site; 3) features of the immediate area and region.

Formulation of the Attractiveness Index

There are a number of ways in which the formulation of the attractiveness index could have been approached. Probably the most reliable method would have been an on-site interview designed to determine those factors which the user could identify as influencing the selection of a particular site for use. Given a limited research budget, the interview method was rejected because of prohibitive cost. The mailed questionnaire technique was rejected for the same reason.

Also considered was a "college student experiment", in which students would have, through pictures or questionnaires, rated site characteristics and their influence on selecting a site. This would have been far less costly than either of the above methods, but was considered to be of questionable validity due to the likelihood of limited experience with boating and public access site use: over 80% of the respondents in Govoni's study were over 21 years old.[26]

The "professional judgment" method was selected for the formulation of the attractiveness index in this study. The instrument was initially worked out by the author and Dr. Warner, who designed the original benefit estimation study. The index was created on the basis of reason, inspection of the 16 sites on which survey data was taken, and review of previous research involving the use of attractiveness measures. The index was refined through consultation with Michigan State University faculty members and personnel from the Waterways Division.

Several schemes for developing the actual index were discussed. An early scheme involved the identification of four major, equally weighted categories: convenience, land based attractiveness, water based attractiveness, and area attractiveness. Each category included a number of components. It was felt that the relative importance of various components could not be adequately reflected in this scheme. The system finally adopted centered on a ranking of

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[26] Govoni, op. cit., p. 18.

the expected importance of various components to users. It seemed appropriate to rank the components separately for various types of users--boaters, fishermen using a boat, and non-boating users. Once a ranking of the components was agreed upon, each component was given a weight reflecting its expected relative importance to each category of user. It became apparent that the boater and boating fisherman indices were sufficiently similar to justify a combination of the two for all boating users.

It was at this point that accessibility of the site was separated out and formulated into a separate variable. Accessibility was not as closely linked conceptually to attractiveness as were the other components. Also, it seemed to be of sufficient importance to warrant separate attention.

The attractiveness index is a composite measure using a number of weighted components (to be discussed in following sections) which, added together, provides a single measure of attractiveness. The value of this measure can be easily introduced to the regression equation for site visitation. It is also conceptually congruent with Levine's "bundle theory" (see Literature Review). There is, however, no way to assess the importance of any single component of the measure since individuality is lost in the aggregation process.

Assumptions and Problems

The primary assumption in the formulation of the attractiveness index in the above manner is that it is possible to determine those factors which are important to users in the selection of a site, weigh the relative importance of each accurately, and evaluate the components in a manner consistent with the evaluation of users without actually consulting a sample of those users.

Given the above, it must be assumed that, where aggregate behavior is concerned, individuals given a choice between alternative sites will rank these sites in the same order. Several potential problems can be discussed here. First, if the sites are not completely discriminable (i.e. if some sites are not obviously better than others), this assumption will not hold. It is expected, however, that generally the user will be able to discriminate sites adequately for these purposes. Another problem here is the "to whom for what" problem: different categories of users are likely to define attractiveness in different ways. In an attempt to deal with this, boating and non-boating users are separated. But it is possible that finer divisions of these categories are needed, and/or that division based on socio-economic or demographic characteristics is needed. Finally, perception and evaluation of a site by different users, and their manifestation in preferences, may not be consistent. Reichardt notes that "not only does the perception and evaluation of an environment vary from person to person, it is also subject to change by the person himself in accordance with changing situations...people also adjust to conditions which a great majority might consider bad."[27]

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[27]Robert Reichardt. "Approaches to the Measurement of Environment", International Social Science Journal. 22, 4 (1970), p. 664, 665.

A third assumption is that all individuals will have knowledge of the alternative opportunities and will choose the "optimal site" in terms of distance, attractiveness, and accessibility as they are defined in this study. While the Michigan DNR publishes a directory of launching sites,[28] many site users likely do not have one in their possession and may not through other means be informed of all alternative sites in an area.

A fourth assumption is that attractiveness is conceptualized by users as an additive composite of the selected components of attractiveness. It may be that the features interact in other than an additive manner.

The assumptions point to problems of selection, evaluation, and measurement of components. An attempt was made to select as wide a variety of components as possible to describe attractiveness, since many features of a site are likely to influence site use where a number of alternative sites are available. A problem arises, however, where only a few sites are available for use in an area, a situation which occurs in relatively few areas in Michigan.

Once selected, the components had to be ranked in a manner expected to be consistent with the rankings of users. The combined professional judgment method previously discussed is hopefully reasonably accurate in this regard.

Measurement of some components posed a further problem. Aesthetics, and its associated problems of measurement, was avoided as much as possible. Generally, characteristics

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[28]"Michigan Boat Launching Directory" (Department of Natural Resources: Lansing, Michigan, March, 1974).

which could be evaluated from the site without any special equipment--in other words, what the users themselves could evaluate--were used for measurement purposes.

In spite of the assumptions necessary and the related problems regarding the formulation of attractiveness indices, it was felt that a sufficiently accurate representation could be achieved to account for variation in the sites with some accuracy, and to indicate whether a more precise representation should be attempted. The author agrees with Clawson and Knetsch when they state that: "Individual tastes vary greatly, yet there is some consensus as to what is good and what is fair; and there would often be general agreement as to what is poor".[29]

Selection of Components and Data Collection

As previously stated, the attractiveness index is based on judgment. Components were selected largely on the basis of reason and review of the literature. The findings of Govoni in his study of public access site attractiveness were influential in the selection and evaluation of components. Components were selected to reflect: 1) the aesthetics of the site and the lake; 2) features related to user convenience; 3) the "activity potential" of the site; 4) the general attractiveness of the region or area to recreationists.

Recall that each attractiveness index (boater and non-boater) is a composite of its individual components, multiplied

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[29]Clawson and Knetsch, op. cit., p. 166.

by their respective weight. The attractiveness index weighted score is calculated using the following formula:

$$A_i = aE_i+bP_i+cR_i+dJ_i+eV_i+fQ_i+gF_i+hT_i+kB_i+lS_i+mW_i+nC_i$$

A_i = attractiveness of site i

E_i = approach road quality

P_i = parking lot quality

R_i = launching ramp type

J_i = rest room facilities

V_i = vegetative cover (activity oriented)

Q_i = shoreline development

F_i = shoreline footage usable for recreation

T_i = shoreline type

B_i = lake bottom materials at site

S_i = fishing success

W_i = relative water clarity

C_i = regional attractiveness

a-n = weights assigned to components

Each component is defined in detail in the next section.

In May, 1976, Dr. Warner and the author visited each of the 16 survey sites to gather data on those components which required on-site inspection. Data were taken on approach road quality, parking lot quality, rest room facilities, vegetative cover, shoreline development, shoreline footage, shoreline type, lake bottom materials, and relative water clarity. In addition to on-site inspection, data was obtained from: 1) the "Michigan Boat Launching Directory"; 2) a questionnaire sent to DNR Regional Fisheries Biologists; 3) the "1974 Michigan Boating Study."[30]

Data for sites in Region III to test the model were obtained in a similar manner. The author visited those sites in September, 1976. Information which required on-site inspection for sites in Region II was obtained through a questionnaire filled out by Waterways Division field personnel in that region. The questionnaire used appears in Appendix A.

Definition, Scoring, and Weighting of Components

Once the components of the attractiveness variable were identified, they were ranked in order of their expected importance to boating and non-boating users. A weight or multiplier was assigned to each component to reflect the expected relative importance of each to users. Weights were assigned to total 100, to facilitate conceptualization of each component's relative importance.

The non-boater index is slanted toward swimming and sun-bathing users. Warner found that 23.4% of all site users indicated that swimming was their primary activity on the site.[31] In a study of non-boating site use, Mullen found that 33% of the non-boating users observed were swimming or wading while 25% were sunbathing. Other activities observed

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[30]Michael and Holly R. Chubb. "1974 Michigan Recreational Boating Study", Report #4 (Recreation Resource Consultants: Lansing, Michigan, Sept., 1975).

[31]Warner. op. cit., p. 49.

by Mullen were: sedentary activities (anyone not engaged in some other readily discernable activity), 30%; picnicking, 8%; dock/shore fishing, 3%; active play, 2%.[32]

The mean of each component's two weights (boater and non-boater) became the weight in a combined users or "total visit" model. Table 4 shows the weighting of components under each of the three systems.

Each component of the index was scored on a 10 point scale. It was felt that this would provide an adequate range of variation and would facilitate the conceptualization of scores. Specific scores were arrived at subjectively. Recall that the attractiveness index weighted score for a site is calculated by multiplying each component score by its assigned weight and adding the products. The scoring and weighting system allows for a maximum weighted score for any site of 1000. Each variable is explained in the following paragraphs.

A_i = <u>Approach Road Quality</u>

	Score
Hard Surface	10
Improved (gravel)	8
Unimproved (dirt)	5
Unimproved (single lane)	2

The approach road refers to the road which leads to the entrance road of the access site. A paved road is generally easier on cars and their occupants than gravel roads,

[32]Nancy E. Mullen. "Patterns of Non-boating Use at Sixteen Selected Public Access Sites in Michigan." Technical Paper (Michigan State University, January 1976). p. 58.

Table 4

Rank and Weight of the Components of the Attractiveness Index

To Boater	Wt	To Non-boater	Wt	Combined	Wt
Ramp (4.28)	20	Beach Type (4.38)	20	Beach Type	17
Beach Type (4.01)*	14	Water Clarity (4.28)	14	Water Clarity	12
Water Clarity (3.88)	11	Vegetative Cover	13	Ramp	11
Fishinq Success	11	Toilit Facilities (4.30)	12	Toilet Facilities	11
Toilet Facil. (4.20)	10	Shoreline Dev. (3.67)	8	Vegetative Cover	10
Vegetative Cover	6	Shoreline Footage	8	Shoreline Dev.	7
Shoreline Dev. (2.84)**	6	Regional Attractiveness	8	Regional Attract.	7
Regional Attract.	6	Lake Bottom Material	6	Fishing Success	6
Parking Lot Quality	6	Parking Lot Quality	4	Lake Bottom Material	5
Approach Road Quality	5	Approach Road Quality	4	Parking Lot Quality	5
Lake Bottom Material	4	Fishing Success	2	Shoreline Footage	5
Shoreline Footage	1	Ramp	1	Approach Road	4
Total	100		100		100

Numbers in parentheses are scores from Govoni's Study: range is 1--not important to 5--very important. Boater scores are average of pleasure boaters, fisherman, and waterskiier categories; non-boater scores are average of swimmer and sightseer categories.

*"Presence of sandy beaches"
**"Lack of Shoreline Development"

and gravel roads are preferred to dirt. It is expected that this is of more importance to the boating user pulling a boat on a trailer. Site visitors are expected to find a site more attractive if the approach road is of high quality, i.e. paved with two full lanes. The effect may, however, be a negative one--a poor road will be discouraging, but a good road may not "draw" users to the site. For this reason, this component is weighted rather low for both boaters and non-boaters: 5 and 4 respectively.

P_i = Parking Lot Quality - 3 components

	Score
1) Surface Material	
Hard Surface	3
Gravel	2
Dirt	1
2) Parking Spaces	
46+	5
36-45	4
26-35	3
16-25	2
5-15	1
3) Ease of Launching	
Launching "spur"	1
Adequate turning radii	1

The parking lot component was seen as consisting of three parts: surface material, parking capacity, and ease of launching and maneuvering. Surface material considerations are similar to those for the approach road, but will have less significance since there is no need for travel over the surface for any great distance.

The capacity of the parking lot will have an effect not only on how many users can conveniently use the site but also on perceived capacity--a large parking area will provide the user with some assurance that parking spaces will be available upon arrival. A large parking lot at an otherwise unattractive site probably will not attract users, but a low capacity lot at an otherwise attractive site would tend to discourage users. The number of spaces is counted on the basis of the number of car-trailer combinations which can be accomodated.

Two factors were considered as contributing to ease of launching and maneuvering at the site. The presence of a launching "spur" (an extension of the approach to the ramp which a vehicle can be pulled into, so that the trailer can be backed straight into the water) facilitates the launching process. Some sites observed have tight corners and other features which could make maneuvering about the site, especially with a trailer, somewhat difficult. The site was appraised subjectively on this point. It is expected that new sites, designed according to present Waterways Division standards, will have adequate maneuvering space, and most will likely have the launching "spur."

As with the approach road, the effect is more likely negative than positive, so the component is weighted relatively low (6 for boater, 4 for non-boater). It is expected to be more important to boaters to the extent that maneuvering with a trailer is not hindered and there is sufficient space to park a car-trailer combination.

R_i = Ramp Type - 2 components

1) Ramp Type

Description	Score
A hard surfaced ramp, with sufficient water depth to accomodate all trailerable water craft. (Waterways Code 1)	8
A hard surfaced ramp in areas of limited water depth, where launching and retrieving may be difficult. (Waterways Code 2)	6
A gravel surfaced ramp, suitable for medium sized and smaller boats only. (Waterways Code 3)	4
A launching area suitable for car-top boats and canoes only. (Waterways Code 4)	2

2) Presence of Skid Pier

	Score
Skid pier on site	2
No pier on site	0

A "Code 1" ramp is the most versatile ramp, allowing access to any trailerable craft. Going down the list, each ramp type is progressively more restrictive with lower potential use. This is certain to have a significant effect on the boating use a site will receive. The presence of a skid pier (so called because it is designed to be easily slid into the water in the spring and out in the fall) eases the launching and retrieval of a boat, facilitates boarding, and provides a mooring point while the car is being parked.

The ramp type is expected to be the prime determinant of the level of boating use a site will receive. In Govoni's study, ramp type was rated 4.28 (on a 5 point scale, average of all boaters). To the non-boating user, ramp type is expected to be of little importance. The weights assigned are 20 and 1, respectively.

J_i = Rest Room Facilities

	Score
Two Privies	10
One Privy	5
No Privy	0

No attempt was made to distinguish between different types of facilities, i.e. pit toilets, chemical toilets, etc. Nor was there an attempt to incorporate cleanliness or quality of upkeep in the component. The assumption here is that separate facilities for men and women will be viewed by users as more attractive than a single privy, and that the lack of facilities is considered unattractive.

Boaters and non-boaters alike rated the presence of rest room facilities very high in Govoni's study (average of 4.20 and 4.30, respectively). A higher ranking by non-boaters seems reasonable, since they are likely to be spending more time on the site itself. The weight assigned in the boater index is 10; for non-boaters, 12.

V_i = Vegetative Cover at Site

The vegetative cover component of attractiveness requires a somewhat subjective appraisal of the site's "activity potential" and "visual quality." The types of activities which a site can support is seen as being directly related to the type of vegetation, or lack of it, found on the site. The first step in determining the score for a site is to place it in one of the following categories:

1) 8 to 10 points: vegetative cover suitable for and conducive to a wide range of on-site activities, especially swimming and sunbathing. The primary

consideration is a large (at least 50' in width) open beach area. Sand is considered most desirable, followed by grass. Some tree cover on the site is desirable but not necessary for a site to receive a score in this range. Weed growth in the immediate lake area should be absent or minimal.

2) 4 to 7 points: vegetative cover which will in effect limit or discourage, but not necessarily preclude, use of the site for beach-oriented activities. Included here are limited beach areas due to small size (limited or narrow frontage) or heavy shade from nearby tree cover; moderate weed growth in the immediate lake area. Open grass or sand not adjacent to the lake would be appropriate for this range.

3) 1 to 3 points: vegetative cover which will heavily impact or preclude use for most or all on-site activities and with limited or no areas at the site suitable for non-beach activities. Included are tree-lined shoreline, marsh, or other factor limiting access to the lake except at the ramp; heavy weed growth in the immediate lake area.

Once the site is placed into one of the above categories, a subjective judgement of the "visual quality" of the site is used to determine the precise score to be used. A visually attractive site is scored in the upper part of the range, moderately attractive in the middle, and sites of low visual quality at the bottom of the range. Where it seems necessary, a non-integer score may be given to a site.

Mullen (1976) reports that 25% of the non-boating use of public access sites was sunbathing and 33% swimming or wading. The vegetative cover component is based largely on the attractiveness for sunbathing and swimming due to their popularity. Fishing from shore was given little consideration because very little of this activity was observed at the sites.

Although the vegetative cover component is slanted heavily to non-boating use of the site, it is expected to be of some influence on boating use also. While the boater is primarily interested in a quality boating experience-cruising, waterskiing, fishing--it is likely that many boaters will be attracted to a site which offers other potential activities. Govoni found that 50% of the boaters were also at the site for swimming, and that 30% were also sunbathing.[33] The weight of this component of the boating index is 6.

Non-boating use of a site is expected to be heavily influenced by the vegetative cover as defined, since it will to a large degree determine those activities which can appropriately be carried out on a site. It is weighted 13 for non-boating users.

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[33]Govoni. op. cit., p. 24.

S_i = Shoreline Development - 2 components

1) Percent of Shoreline Developed

Percent of Shoreline Developed	Score
0 to 20	5
21 to 40	4
41 to 60	3
61 to 80	2
81+	1

2) Visual Quality

a. 4 to 5 points: good to excellent; development unobtrusive all around lake; heavy tree or other vegetative cover up to shoreline, rolling terrain are possible considerations.

b. 2 to 3 points: fair; development somewhat obtrusive, vegetative cover moderately attractive.

c. 1 point: poor; development very obtrusive, little vegetative cover; houses or other developments highly visible.

The percentage of shoreline development is determined by estimating the development which can be seen from the access site. Heavily developed lakes are likely to be more crowded with boaters than lakes with little development. Crowded conditions are expected to reduce the enjoyment of the experience, creating problems in maneuverability and safety.

A heavily developed lake is often less aesthetically appealing than lightly developed lakes. It was recognized, however, that some undeveloped lakes lack aesthetic appeal (in fact, they may lack development for this reason) while others with a high percentage of developed shoreline may have high visual appeal. The second element of the shoreline development component represents an attempt to deal with this.

Shoreline development is expected to have a somewhat lower influence on boaters than on non-boaters since many non-boaters report coming to public access sites for sightseeing. Govoni found that boaters rate the lack of shoreline development at 2.84, while the non-boater rating was 3.67 (averages, on a 5 point scale). The weights assigned to this component for boaters and non-boaters are 8 and 6, respectively.

F_i = <u>Shoreline Footage Suitable for Recreation</u>

	Score		Score
up to 50'	1	251 to 300'	6
51 to 100'	2	301 to 350'	7
101 to 150'	3	351 to 400'	8
151 to 200'	4	401 to 450'	9
201 to 250'	5	451' +	10

Shoreline footage suitable for recreation is defined as the amount of shoreline which provides easy, direct access to the water, including the launching ramp. Presumably, the longer the usable shoreline, the more use a site can accomodate. This will be of little importance in determining the level of boating use, and is weighted 1 on the boating attractiveness index. It will likely have some effect on the amount of non-boating use, and thus receives a weight of 8.

T_i = <u>Shoreline Type</u>

	Score
Sand	10
Grass	7
Gravel/bare soil	3
Timbered	1
Weeds/marsh, rock	0

The shoreline type and vegetative cover components are related, but the latter is activity oriented while shoreline type is based on the physical resource.

The ratings used in this study are consistent with those used by Hodgson[34], who scored beach types as follows: sand, 40; grass, 30; gravel, 20; rock, 10; and organic, 0. The U.S. Department of Agriculture Forestry Service[35] has used a similar scheme, with scores of 5 to 1 for sand, gravel, timbered, soil, and rock, respectively.

Sand is generally considered to be the most desirable beach material. It is clean-appearing, comfortable, and suitable for a wide range of activities for all ages. Grassy beach areas are cooler than sandy ones and offer less opportunities, especially for children. Grass may be less clean, at least in appearance. Gravel offers a less comfortable and less clean environment for beach activities, while a timbered shoreline often will "shade out" much activity. Organic, marshy and rock shorelines will discourage all but the most dedicated beach users.

Where more than one shoreline type is found on a site and no one type seems dominant, an average score of two or more type scores was used.

Shoreline type is expected to influence boating use of a site in two ways: first, a sandy or grassy beach will

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[34]Hodgson. op. cit., p. 36.

[35]U.S. Department of Agriculture, Forest Service. "Work Plan for the National Forest Recreation Survey--A Review of Outdoor Recreation Resources of National Forests." (Washington, D.C.; August, 1959).

facilitate launching by providing a place to pull the boat up while parking the car or engaging in on-site activities; secondly, a high quality shoreline will encourage on-site activities as an "added attraction" to the boater. Boaters interviewed by Govoni rated "presence of sandy beaches" quite high at 4.01. This component was given a weight of 14 for boaters.

Non-boaters interviewed by Govoni rated the "presence of sandy beaches" at 4.38, the highest score for any feature included in his study. It is not unreasonable to expect that shoreline type will be the prime determinant of non-boating use, and it is weighted at 20 for non-boating attractiveness.

B_i = Lake Bottom Material at Site

	Score
Sand	10
Gravel/stone	7
Mud/silt	4

The lake bottom material is scored by visual inspection at the site. At sites with gravel ramps, this added material is not considered to be the lake bottom material for the purposes of scoring this component.

Bottom material will affect to some degree the experience of the boater as well as the non-boater. The boater may have to wade into the water while launching and retrieving the boat--especially if there is no pier on the site. A sandy bottom will be more pleasant than other types. Water-skiing is somewhat discouraged if near-shore muck must be avoided. For the non-boating user, expected to be more influenced by lake bottom material than the boater, swimming is most heavily impacted by bottom type. Even the sightseer may prefer a sandy bottom, though, since it will offer a cleaner, more aesthetically appealing scene than the other types. A fisherman may prefer any of the bottom types, depending on the species of fish desired.

Where more than one bottom material was observed at a site an average score was used.

Lake bottom material is weighted 4 for the boater attractiveness index and 6 for the non-boater.

S_i = Fishing Success

	Score
Excellent	10
Very good	8
Good	6
Fair	4
Poor	1

Fishing success at all of the lakes used in this study was determined by contacting regional fisheries biologists employed by the Department of Natural Resources. A questionnaire was sent requesting an estimate of the fishing success for study lakes located in their region. They were asked to use the above scale in assessing fishing success in answer to the question "How would you rate the relative fishing quality, in terms of fishing success, of the lake?" All questionnaires were returned.

Warner found that fishing was the primary site use for 29.3% of all users.[36] The fishing success which can be

[36]Warner. op. cit., p. 49.

expected at a lake is likely to be influential in the decision to fish at that lake. However, very little shore fishing was observed at the sites.[37] The weight used in the boater attractiveness index is 11, for non-boaters, 2.

W_i = Relative Water Clarity

	Score
Excellent	10
Moderate	6
Poor	2

A subjective appraisal by visual inspection of the water clarity at the site determines the score for this component. Scoring of this component for the survey sites was done in the spring, while the test sites were observed in the fall. A potential problem here is that clarity may change over the course of the summer, perhaps having an impact on the level of usage a site will receive. More objective criteria were discarded in favor of clarity for the following reasons: 1) water quality information was not available for all lakes in the study, and this information suffers from the same potential lack of consistency as clarity; 2) it was felt that users' perceptions of water clarity would be more likely to influence use. In some cases polluted water may appear clear, while murky water may be quite free of pollutants. Except in extreme cases, where swimming is banned due to poor water quality, it is likely that clear, albeit polluted water, would be more appealing than murky water.

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[37]See footnote 32.

Users across the categories used in the Govoni study attribute fairly high importance to "clearness of water." The average rating for all users is 4.00 on a 5 point scale, with swimmers rating it somewhat higher (see Table 3). Water clarity was weighted 11 for boaters and 14 for non-boaters.

C_i = Regional Attractiveness - 2 components

1) Launchings per capita (destination county)

	Score
up to .16	1
.17 to .35	2
.36 to .70	3
.71 to 1.20	4
1.21 to 1.70	5
1.71 +	6

2) Lake Acreage (destination county)

	Score
up to 5000	1
5,001 to 10,000	2
10,000 to 15,000	3
15,000 +	4

Launchings per capita data was obtained from the "1974 Michigan Boating Study".[38] All Michigan counties were ranked, then divided into six equal categories to arrive at the scores. Launchings per capita are shown in Appendix B.

County lake acreage was obtained from "Water Bulletin #15".[39] The counties in Michigan's Lower Penninsula were ranked, then divided into four equal categories to score this

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[38] Chubb. op. cit.

[39] Humphrys, C.R. and Colby, Joyce. "Summary of Acreage Analysis Charts from Lake Inventory Bulletin I-83." Water Bulletin #15. (Department of Resource Development, Agriculture Experiment Station, Michigan State University, 1962).

element. Appendix C is a tabulation of Lake acreages for counties in Michigan's Lower Penninsula.

The regional attractiveness component is designed to differentiate areas of Michigan which may be more attractive than others to recreationists, and those seeking water-oriented recreation in particular. Launchings per capita was the best available measure of boating activity in the state. A new site located in an area of high boating activity might be expected to receive a higher amount of boating usage than one in an area of low activity, except in situations where low boating activity is a reflection of limited supply. In this situation, a new site might receive disproportionately high usage.

A county with high lake acreage probably attracts more water-oriented recreationists due to the potentially larger number of alternatives in such a county. Any given lake in a low-acreage county, however, may receive high local usage.

Regional attractiveness probably has a similar effect on boating and non-boating use, though non-boaters may be more likely to "drop in" on a site than boaters pulling a boat on a trailer. The weight in the boater index for regional attractiveness is 6, for non-boaters, 8.

Table 6 on page 58 shows the attractiveness index weighted scores, along with accessibility scores and lake acreage (all site specific variables). The characteristics of the 16 survey sites are shown, along with the scores given for each component of attractiveness, in Appendix D.

Formulation of Accessibility Variable

Early in the study accessibility to public access sites was separated from the attractiveness measure. The relationship of accessibility to attractiveness was less obvious than that of other components and it seemed of sufficient importance to include in the model as a separate variable. A 20 point scale was devised for the three part system. The first two parts (appears on map, convenience to expressway system) can be scored using the Michigan Official Transportation Map distributed by the Michigan State Highway Commission, while the score for the third element (ease of finding) must be assessed by someone who has travelled to the site. The scoring system for accessibility is shown below:

	Score
1. Appears on map	2
2. Convenience to expressway[40]	
a. 1 to 5 miles from nearest exit	12
b. 6 to 10 miles from nearest exit	10
c. 11 to 20 miles from nearest exit	8
d. more than 20 miles from nearest exit	0
3. Ease of finding site	0 to 6 (subjective)

Sites which can be readily located and are convenient to Michigan's expressway network are expected to receive more usage than those difficult to find or located in areas served by lower quality highway systems.

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[40]Expressways are limited access divided highways with all crossroads separated by overpasses and underpasses.

Table 5 indicates accessibility score formulation for the 16 survey sites.

Variables Eliminated from the Warner Model

As was briefly described in the Literature Review, two variables--Gravity and Median Family Income--failed to enter most of the visitation equations developed by Warner at both the .05 and .10 levels of significance.

Median family income was expected to impact usage in a positive direction, i.e. site use would increase with increased family income. This variable was found to be significant at the .05 level in two site specific equations and in the Subregional Model (Region III, East), the latter in the opposite direction expected. It entered two more site specific equations at the .10 level of significance

The Gravity Variable was a measure of competing water recreation opportunities, based on a weighted combination of lake acreage, stream miles, and Great Lake shoreline miles within two hours driving time of the origin "time zone." Competing opportunities would be expected to have a negative relationship with usage of sites. It entered neither the site specific nor the aggregated models at the .05 level of significance. The Gravity Variable enters the Region II model at the .10 level.

Since neither of the above variables were significant in the majority of the visitation equations generated by Warner it was decided that they would be dropped from the models created in this study. As will be seen in the next section,

Table 5

Accessibility Score Formulation, Survey Sites

Site	On Map[1]	Convenient to Expressway[2]	Ease of Finding[3]	Total
Austin	2	12	3	17
Orchard	2	12	6	20
Wolverine	0	12	2	14
Sherman	2	12	0	14
Fenton	2	12	6	20
Union	2	12	5	19
Swan	0	0	1	1
Muskrat	2	12	2	16
Higgins	2	12	6	20
St. Helen	2	12	5	19
Chippewa	2	0	0	2
Clear	0	0	6	6
Wixom	2	10	0	12
Big Star	2	0	0	2
Wiggins	2	8	0	10
Big Twin	2	0	0	2

[1]On Michigan Official Transportation Map, 2 points; not on map, 0.

[2]1 to 5 miles from nearest exit, 12 points.
6 to 10 miles from nearest exit, 10 points.
11 to 20 miles from nearest exit, 8 points.
more than 20 miles from nearest exit, 0 points.

[3]Subjective, 0 to 6 points.

Table 6

Attractiveness and Accessibility Scores, and Surface Lake Acres, Survey Sites

Site	Attractiveness Boater	Attractiveness Non-boater	Attractiveness Combined	Access	Lake Acres
Austin	780	759	773	17	1050
Orchard	792	760	779	20	788
Wolverine	499	423	457	14	241
Sherman	828	737	779	14	120
Fenton	650	582	612	20	845
Union	492	303	396	19	518
Swan	474	430	445	1	127
Muskrat	517	345	427	16	39
Higgins	804	711	753	20	9900
St. Helen	815	848	832	19	2400
Chippewa	774	799	781	2	770
Clear	562	581	565	6	130
Wixom	727	719	724	12	1480
Big Star	885	785	830	2	912
Wiggins	657	610	633	10	345
Big Twin	556	581	562	2	215

this facilitated the change made in visitor origin data distribution.

Aggregation of Data into Concentric Zones

Early in the study it was decided to aggregate the transportation time zones used by Warner for distribution of origin points into concentric zones around each site. A number of reasons for this action can be cited:

1. Early trials indicated that the additional variables (Attractiveness and Accessibility) inserted into the model improved predictive accuracy, but even with these additions the model was still inadequate for making site specific predictions.

2. The data base was considered to be inadequate for the time zone format, considering that the 2600 observations must be distributed across 508 zones and among 16 lake destinations. In other words, Warner was attempting to predict visits from geographic areas with an average of only 5 observations per area, distributed among 16 public access sites.

3. Prior to the deletion of the Gravity Variable as it was defined (see previous section) the use of a concentric zone format could not be considered without introducing a vast amount of additional complexity.

4. The concentric zone system would simplify the generation of site visitation predictions. Rather than requiring computer analysis, as did Warner's method, predictions utilizing the concentric zone system, can be calculated

using only a desk calculator. Simplicity was an objective since the client for this research has limited computer access and personnel trained in the use of a computer.

Computer programs were utilized to aggregate user origin data and populations into eight concentric zones 15 minutes in width and eight zones 30 minutes wide around each of the 508 time zones in the state. Not all of these zones were used in the analysis of data.

The Site Visitation Model

The dependent variable in this study is the number of vehicle entries to a public access site from each concentric zone of origin. The model is tested using both total visits from a zone as the dependent variable and division of total visits into the number of boating parties and the number of non-boating parties from a concentric zone of origin.

The independent variables used to explain variation in the number of visitors to a public access site are: 1) population of origin zone (the zone in which the user resides); 2) travel time between the center of the origin zone and the destination public access site; 3) the attractiveness of the public access site; 4) the accessibility of the site; 5) the surface lake acreage of the public access site. Table 6 shows the values for all site specific variables for the survey sites.

A multiple regression routine written under the Statistical Package for Social Science (SPSS) was applied to the survey data and independent variable inputs. The 16 zones described in the previous section were used to fit the model to the data. The regression routine produced coefficients to be used in the following equation:

$$Y_{ij} = 10^{C} P_i^{B_1} d_{ij}^{B_2} A_j^{B_3} C_j^{B_4} S_j^{B_5}$$

Y_{ij} = number of vehicle entries from origin zone "i" to destination site "j"

C = constant

B_1-B_5 = regression coefficients to be estimated

P_i = population of zone "i" (origin)

d_{ij} = travel time from zone "i" to site "j"

A_j = attractiveness of site "j"

C_j = accessibility of site "j"

S_j = surface acreage of lake at site "j"

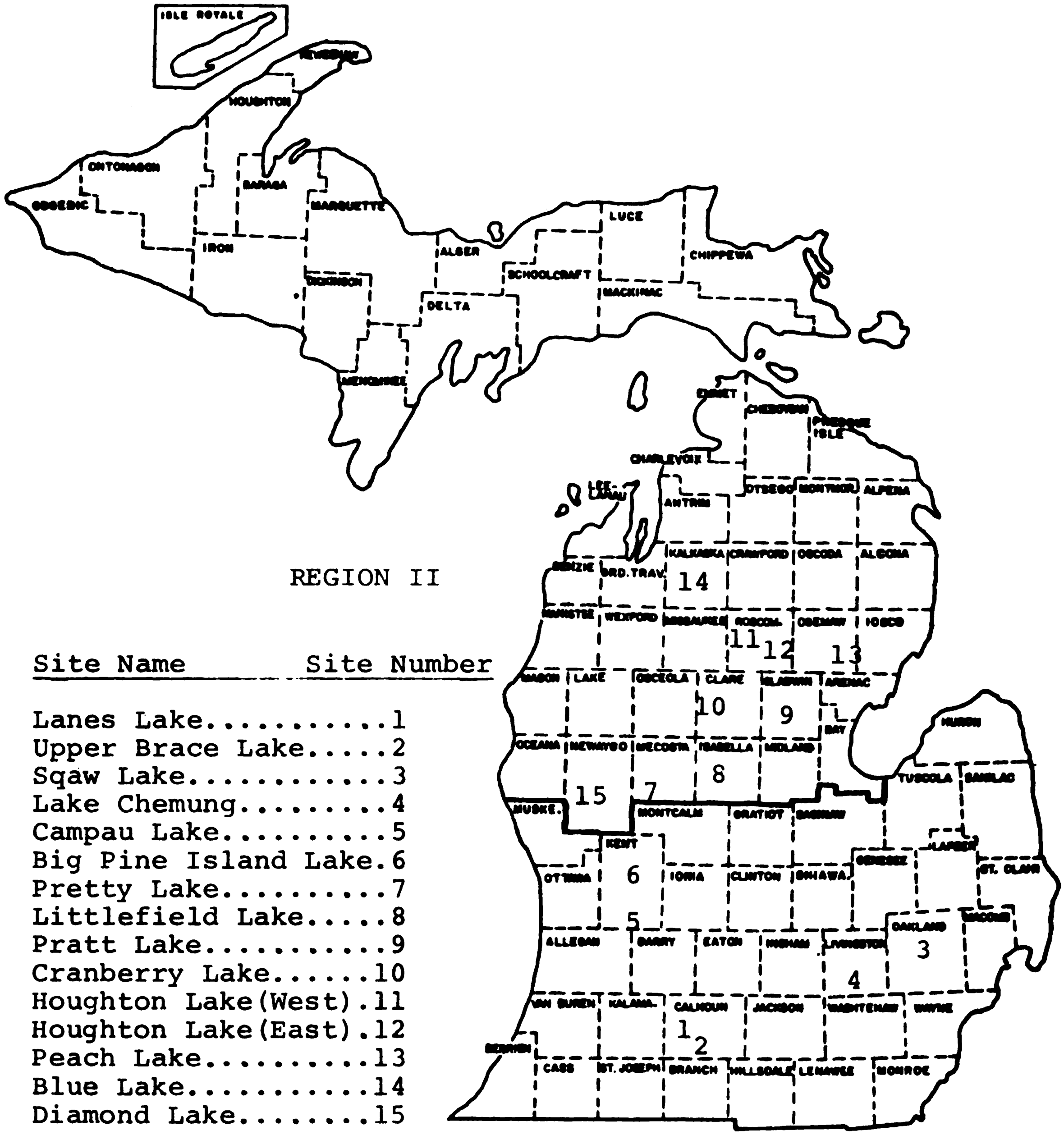
The equation is used to predict vehicle entries from single zones. It is repeated--using the data peculiar to each zone (population and travel time)--for each zone used in the analysis. Of the 16 concentric zones created (see previous section) only the eight zones nearest the lake (out to two hours driving time away) were used in predicting Region III visitation because nearly 100% of all usage in Region III occurred from within two hours driving time of sites in that Region. Almost 50% of the visitors to sites in Region II drove more than two hours, thus, thirteen zones (out to 4.5 hours driving time away) were used in Region II predictions to reflect this longer distance travel pattern.

The sum of Y_{ij}'s (one Y_{ij} for each of 8 zones in Region III and 13 zones in Region II) obtained using the regression equation is the estimation of the number of vehicle entries to the site during the survey period. This figure must then be expanded to reflect annual vehicle entries since to this point the model predictions are only for entries for the time period covered by the on-site interviews. To calculate the total number of visitors a second expansion factor to reflect average party size is introduced. These expansion factors will be discussed in detail in the next chapter.

Once a model for site visitation was developed and calibrated using vehicle counter data supplied by the Waterways Division the model was tested on a number of "test sites" which also had counters installed. In addition to the four test sites used by Warner to test his models, 11 additional sites were used for testing the models developed in this study. Figure 5 shows the locations of these 15 test sites. Testing procedures are described in the following chapter. Accessibility Variable calculations for the test sites are shown in Table 7 and site specific data inputs (Attractiveness, Accessibility, and Lake Acres) in Table 8. The characteristics and Attractiveness component scores for the test sites are shown in Appendix E.

Figure 5

Waterways Division Access Sites Selected
for Prediction Model Testing



Site Name	Site Number
Lanes Lake...........	1
Upper Brace Lake.....	2
Sqaw Lake............	3
Lake Chemung.........	4
Campau Lake..........	5
Big Pine Island Lake.	6
Pretty Lake..........	7
Littlefield Lake.....	8
Pratt Lake...........	9
Cranberry Lake......	10
Houghton Lake(West).	11
Houghton Lake(East).	12
Peach Lake..........	13
Blue Lake...........	14
Diamond Lake........	15

REGION III

Table 7

Accessibility Score Formulation, Test Sites

Site	On Map[1]	Convenient to Expressway[2]	Ease of Finding[3]	Total
Lanes	0	12	6	18
Upper Brace	0	12	4	16
Squaw	0	0	2	2
Campau	2	12	2	16
Chemung	2	12	5	19
Big Pine Island	0	0	3	3
Pretty	0	0	6	6
Littlefield	2	8	5	15
Pratt	2	8	6	16
Cranberry	0	12	3	15
Houghton (West)	2	12	5	19
Houghton (East)	2	12	4	18
Peach	0	12	5	17
Blue	2	0	3	5
Diamond	2	0	6	8

[1]On Michigan Official Transportation Map, 2 points; not on map, 0.

[2]1 to 5 miles from nearest exit, 12 points.
6 to 10 miles from nearest exit, 10 points.
11 to 20 miles from nearest exit, 8 points.
more than 20 miles from nearest exit, 0 points.

[3]Subjective, 0 to 6 points.

Table 8

Attractiveness and Accessibility Scores, and Surface Lake Acres, Test Sites

Site	Attractiveness Boater	Non-boater	Combined	Access	Lake Acres
Lanes	433	400	411	18	24
Upper Brace	477	457	460	16	56
Squaw	549	456	495	2	133
Chemung	528	523	519	19	321
Campau	708	664	684	16	190
Big Pine Island	153	432	462	3	223
Pretty	481	450	460	6	120
Littlefield	621	664	637	15	183
Pratt	774	721	747	16	180
Cranberry	428	398	408	15	106
Houghton West	714	837	776	19	19600
Houghton East	759	758	759	18	19600
Peach	704	760	731	17	208
Blue	570	568	569	5	114
Diamond	789	857	825	8	181

CHAPTER IV

RESULTS

This chapter begins with a presentation of several alternative models and initial analysis of these models to determine the "best" one for developing predictions. This is followed by a discussion of the calibration, by means of "expansion factors", of the "best" model and final testing of that model. Finally, the study hypotheses are tested.

Prediction Models

All-Sites-Summed Models

Data for all 16 survey sites were aggregated to produce all-sites-summed equations for boating visits, non-boating visits, and total visits (boaters plus non-boaters). The following equations were produced through the multiple regression proceedures previously discussed. An asterisk following a coefficient indicates that the variable enters the equation at the .10 level of significance. Standard errors of estimate are shown in parentheses below each variable.

Boater Visitation Equation

$$Y_{ij} = 10^{-.9686} P_i^{.1964*} d_{ij}^{-.5560*} A_j^{.3187} C_j^{.0534} S_j^{.1597*}$$

(.8726) (.0301) (.0543) (.3334) (.0573) (.0547)

$R^2 = .36$ $F = 30.44*$

Non-Boater Visitation Equation

$$Y_{ij} = 10^{-2.122} P_i^{.1703*} d_{ij}^{-.3940*} A_j^{.6895*} C_j^{-.0732} S_j^{.1837*}$$

(.5972) (.0309) (.0558) (.2299) (.0608) (.0557)

$R^2 = .30$ $F = 22.92*$

Total Visit (Boaters plus Non-Boaters) Equation

$$Y_{ij} = 10^{-2.236} P_i^{.2698*} d_{ij}^{-.7051*} A_j^{.7725*} C_j^{-.0655} S_j^{.2310*}$$

$R^2 = .41$ $F = 37.14*$

Y_{ij} = number of vehicle entries from origin zone "i" to destination site "j"

P_i = population of zone "i"

d_{ij} = travel time from zone "i" to site "j"

A_j = attractiveness of site "j"

C_j = accessibility of site "j"

S_j = surface lake acreage of lake at site "j"

*significant at the .10 level

Accessibility enters none of the equations at the .10 level of significance, and only the "boat" model in a positive direction. Attractiveness fails to enter only the "boat" equation at the .10 level.

Given that the R^2 value for the "total visit" equation is higher than that of either of the other models, and that predictions using the total visit model are more accurate (see section on Testing the Models), the boater/non-boater distinction was dropped at this point. In subsequent forms of the model boaters and non-boaters were combined.

Regional Models

Differences in the travel patterns between Department of Natural Resources Region II and Region III (see Figure 5) prompted the aggregation on data on a regional basis. The differences in travel patterns will be discussed further in the section on Testing the Models in this chapter. The following equations were produced through multiple regression proceedures.

Region II Total Visit Equation

$$Y_{ij} = 10^{-5.382}\ P_i^{.5280*}\ d_{ij}^{-.8642*}\ A_j^{1.661*}\ C_j^{.2497*}\ S_j^{.0546}$$

(2.612) (.0533) (.1079) (1.009) (.1307) (.1369)

$R^2 = .52$ $\qquad$ $F = 26.35$

Y_{ij} = number of vehicle entries from origin zone "i" to destination site "j"

P_i = population of zone "i"

d_{ij} = travel time from zone "i" to site "j"

A_j = attractiveness of site "j"

C_j = accessibility of site "j"

S_j = surface lake acreage of lake at site "j"

*significant at the .10 level

The R^2 value for the Region II equation is greater than that found in any of the all-sites-summed equations. All variables except Lake Acreage enter the equation significantly at the .10 level.

Region III Total Visit Equation

$$Y_{ij} = 10^{.4408} P_i^{.0021} d_{ij}^{-.8637*} A_j^{.4956} C_j^{.0725} S_j^{.0537}$$

(.8226) (.4555) (.0743) (.3130) (.0882) (.0806)

R^2 = .53 F = 28.98*

Y_{ij} = number of vehicle entries from origin zone "i" to destination site "j"

P_i = population of zone "i"

d_{ij} = travel time from zone "i" to site "j"

A_j = attractiveness of site "j"

C_j = accessibility of site "j"

S_j = surface lake acreage of lake at site "j"

*significant at the .10 level

As with the Region II equation, the R^2 value for the Region III equation is higher than any obtained with the all-sites-summed equations. Only Travel Time, however, enters the Region III equation at the .10 level of significance.

Testing the Models

Recall that the objective of this study was to create a model or models for predicting visitation to Michigan public access sites (under Waterways Division administration) which would be more accurate in predicting site specific usage than the model developed by Warner. This section and the next (Testing Hypotheses) explore whether or not this objective was achieved.

One test of predictive accuracy is to compare the predictions obtained to the counter data from the 16 survey sites. A far superior test is the model's ability to accurately predict use for sites not included in the survey (for example, the test sites previously mentioned). Thus, in addition to predicting usage at the 16 survey sites, the model was used to develop predictions for the 15 test sites (see Figure 5, page 63). These test sites are inland lakes in Michigan's Lower Peninsula (the same area where the 16 survey sites are located) which have vehicle counters installed. But they are different from the survey sites in a number of respects. Notice in Table 9 that the test sites' size range is wider and that they are in general much smaller lakes. Also, according to Waterways Division counter data, the test sites have received considerably lower use than the survey sites (see Table 10). A site visitation model which accurately predicts usage at these relatively dissimilar sites can be applied to other lakes in the state with more confidence than if the test sites were very similar to the survey sites.

In order to determine which model most effectively predicts usage the least squares correlation between the unexpanded predictions and the vehicle counter counts provided by the Waterways Division was calculated. In general, 1975 counter data was used in calculating correlations, since that is the year survey data were obtained. However, counter problems on some lakes in 1975 indicated that counts from other years were more reliable. Below is a list of lakes where other than 1975 counts were used.

1. Austin Lake: no reliable data were available. This site was used in neither the testing nor the calibration of the model (to be discussed subsequently); survey data from Austin Lake remained in the multiple regression analysis, since counter problems did not influence the data and it added observations.
2. Lake St. Helen: 1976 data were used due to redesign of the site in 1975 resulting in less "drive-through" usage, but no major change in other use patterns.
3. Orchard Lake: 1974 data were used since an entrance fee was instituted in 1975.
4. Houghton Lake: 1976 data were used for the site

Table 9

Comparison of Survey Sites and Test Sites, Region and Acreage

	DNR Region II	DNR Region III	Smallest Acreage	Largest Acreage	Median Acreage
Survey Sites	8	8	39	9900	518
Test Sites	9	6	24	19600	180

Table 10

Waterways Usage Class, Survey Sites and Test Sites

	Class I 15,000+*	Class II 5,000 to 15,000*	Class III 0 to 5,000*
Survey Sites	5	6	5
Test Sites	0	6	9

*Annual vehicle entries, based on 1975 Waterways Division counter data.

on the eastern side of the lake. Lack of proper signing in 1975 was cited by Waterways Division personnel as a probable reason for a tripling of use in 1976, and this was expected to be more representative of actual use. Also, since the model is not designed to handle two sites on the same lake individually (as found on Houghton Lake), the sum of visitations at the two sites is used for testing and calibration purposes.

5. Diamond Lake: 1976 data were used due to redevelopment of the site in 1975 resulting in partial closing.

When unexpanded predictions from each of the models presented earlier were compared with counter data by the least squares correlation process, the r^2 values shown in Table 11 were obtained.[41] It is apparent that the Regional models result in consistently higher r^2 values than the all-sites-summed models. The Regional models are retained for use in generating final predictions, after calibration. No further consideration will be given to the all-sites-summed models.

Expansion of Predicted Values

The models described above can be used to predict usage only for the time period during which interviewers were present on the survey sites. Since annual visitation estimates are desired, the predictions must be expanded to reflect annual

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[41] For an explanation of least square correlation techniques the reader is referred to Steel and Torrie (1960).

Table 11

Least Squares Correlation of Prediction Model Results and Counter Data, r^2 Values

	All Sites Summed Models		Regional Models	
	Boat/no-boat	Total Visit	Region II	Region III
Survey Sites	.17	.35	.62	.85
Test Sites	.66	.67	.85	.66

use rates. This expansion consists of two steps: 1) expansion to annual vehicle entries; 2) expansion of this figure to total visits (based on the average size of the user party). However, herein expansion only to annual vehicle entries is presented because this is the figure which should be used for generating site benefits. Although benefit estimates are not generated in this report, expansion is limited to annual vehicle entries because: 1) expansion to total annual visits is a simple process of multiplying vehicle entries by average visitor party size; 2) expansion to total annual visits is not necessary to test the model; 3) since site benefits are a reflection of travel costs, annual vehicle entries will be a more appropriate figure for estimating benefits at some future date.

Warner expanded predicted vehicle entries to annual figures by dividing the counter data figures by the number of interviews at each site. The average of these site expansion figures yielded the expansion factor to be used in generating predictions at all other sites. The range of expansion factors calculated by Warner was 103 to 639, with an average of 251, which was the figure used by Warner to calculate visitation rates to other inland lake sites. Given the degree of error that is introduced by a range this great, it was decided that predicted visits would be directly calibrated with counter data in this study. Each equation used to generate expanded visits (Region II and Region III equations) was calibrated separately.

The original intention was to develop multiplicative expansion factors for use in each Region. To calculate them, the counter count for each survey site in the Region was divided by the predicted number of vehicle entries for that site. The results of these calculations were averaged to obtain an average expansion factor to apply to model predictions to obtain annual vehicle entries to any site for which such estimates are desired.

In Region II the average expansion factor approach proved satisfactory. The range of individual survey site expansion factors to be averaged was 40 to 127, resulting in a mean value of 84. Obviously, some site visitation rates will be over-estimated while others are under-estimated when this average expansion factor is employed, but in lieu of any better alternative the expansion factor of 84 as a multiplier of predicted visits was adopted for Region II.

In Region III this technique was found to be unacceptable. The range of calculated expansion factors was 54 to 697, too large a spread for usable estimations of use. A graphic representation of predicted visits (unexpanded) and counter data suggested a possible exponential relationship. An exponential regression equation of the following form was fitted to the predicted values and counter data.

$$y = ae^{bx}$$

y = expanded vehicle entries

a = constant

e = 2.713 (natural logarithm)

b = slope

x = predicted vehicle entries (by solution of regression equations)

By using this equation to expand predictions to annual vehicle entries, a good "fit" ($r^2 = .92$) with counter data was obtained. There is no theoretical basis for the use of an exponential relationship as an expansion factor; the lakes included in this study which exhibit high use are located near urban areas, but it is not clear whether this or other factors might be involved. In these areas where a large number of people have easy access to the site and may drive out to a site "on a moment's notice." If much of this type of use occurred during evening hours, when interviewers were not on the site, this would not be reflected in the survey data. Despite its lack of theoretical foundation, the exponential relationship was accepted for generating expanded predictions in Region III for the pragmatic reason that it yielded better results than the average regional expansion factor used for Region II.

The Testing of the Primary Hypothesis

The primary hypothesis as stated earlier was:

> The addition of two variables--Site Attractiveness and Accessibility--and the aggregation of "time zone" data into concentric zones will significantly improve the predictive accuracy of the site visitation model developed by Warner.

Warner selected four lake sites with vehicle counters, reflecting a range of lake acreage and regional distribution, to test the model he developed. His all-sites-summed model was used for predicting site use at these lakes. Table 12 presents a comparison of Warner's predictions and those found using the Regional Models developed in this study.

The least squares correlation procedure was used to test the primary hypothesis. Regions II and III were not considered separately for this purpose, since with only two sites in each Region the correlations would be meaningless. The simple correlation calculated between counter data and predicted values resulted in the correlation coefficients shown below.

	Both Regions Combined
Warner Model	$r = .04$
Revised Model	$r = .74$

That considerable improvement over the Warner model has been accomplished for these four lakes is clear. Since these were the only sites tested by Warner, the primary

Table 12

Comparison of Predictions by Warner's Model and Revised Model

Region III Lake Site	Counter[1]	Expanded Prediction (Warner)	Counter[2]	Expanded Prediction (revised model)
Chemung	24,353	46,616	9,002	8,563
Campau	40,621	20,322	14,482	14,039
Total:	64,974	66,938	23,484	22,602
Region III Lake Site	**Counter[1]**	**Expanded Prediction (Warner)**	**Counter[2]**	**Expanded Prediction (revised model)**
Houghton (West)	32,601	25,493	11,714	13,591
Pratt	13,977	14,013	5,001	10,382
Total:	46,578	39,505	16,715	23,972

[1]Number of visitors

[2]Number of vehicle entries

hypothesis is acepted at this point. One might ask, however, whether this conclusion is well-founded on the basis of the testing of just four sites. The author's doubts on this score prompted the testing of 11 more sites--a total of 15--to determine the new model's ability to predict use at a variety of lakes. Before proceeding with a discussion of the sub-hypotheses, the results of this further testing will be presented.

Unexpanded predictions, expanded predictions, and counter data for survey and test sites in Region II (using the Regional Model for prediction) are shown in Table 13. Table 14 shows the same information for Region III. Also shown in these tables are the amounts and percentages of error between predicted and observed (counter) usage. Calculation of least squares correlation for counter data and expanded predictions yeilded the correlation coefficients (r) and coefficients of determination (r^2) shown in Table 15. Correlations remain at high levels with the larger number of test sites. It should be noted, however, that some fairly large differences between predicted users and observed use (vehicle counts) remain. There is considerable consistency of over-prediction of very low-use sites. The section on Application of the Model in the following chapter will present further discussion of these findings.

The Testing of the Study Sub-hypotheses

Sub-hypothesis #1

> Separate models for boaters and non-boating users will be more effective in predicting site visitation than a single "total visit" model.

The boat/no-boat distinction was dropped due to lower R^2 values and failure to predict visits as well as the total visit model in the all-sites-summed model (see page 74). This sub-hypothesis is rejected.

Discussion of the remaining sub-hypotheses is based on the data found in Table 16.

Table 13

Unexpanded and Expanded Predictions of Vehicle Entries, Actual Counter Measure of Vehicle Entries, Error and Percent of Error of Prediction for Survey Sites and Test Sites in Region II (Regional Model)

Survey Sites	Predictions (Unexpanded)	Predictions (Expanded)[1]	Counter	Error	%Error
Higgins	150.2	12616	10634	1982	18.6
St. Helen	151.9	12759	19183*	-6424	33.5
Chippewa	84.2	7072	9550	-2478	25.9
Clear	64.9	5451	2584	2867	111.0
Wixom	122.8	10315	7572	2743	36.2
Big Star	87.4	7341	5840	1501	25.7
Wiggins	86.5	7266	5775	1491	25.8
Big Twin	34.0	2856	4329	-1473	34.0
Total		65676	65467	209	0.3
Test Sites					
Pretty	41.6	3494	2351	1143	48.6
Littlefield	104.0	8736	4245	4491	105.8
Pratt	123.6	10382	5001	5381	107.6
Cranberry	43.1	3620	1869	1751	93.7
Houghton (West)	161.8	13591	11714	1877	16.0
Houghton (East)	153.9	12927	10834*	2093	19.3
Houghton (Tot.)	315.7	26518	22548	3970	17.6
Peach	119.2	10012	9021	991	11.0
Blue	42.1	3536	4269	-733	17.2
Diamond	130.9	10995	9691*	1304	13.5
Total		77293	58995	18298	31.0

[1]Expansion factor used was 84, the average of survey site expansion factors which were calculated by dividing vehicle entries according to counter data by predicted vehicle entries.

*1976 Counter Data

Table 14

Unexpanded and Expanded Predictions of Vehicle Entries, Actual Counter Measure of Vehicle Entries, Error and Percent of Error of Prediction for Survey Sites and Test Sites in Region III (Regional Model)

Survey Sites	Predictions (Unexpanded)	Predictions (Expanded)[1]	Counter	Error	% Error
Orchard	53.6	36840	37369**	529	1.4
Wolverine	37.6	5350	4833	517	10.0
Sherman	47.1	16823	16015	808	5.0
Fenton	47.6	17869	26988	-9119	33.8
Union	37.1	5037	2003	3034	151.5
Swan	29.5	2014	3021	-1007	33.3
Muskrat	33.2	3147	4007	-860	21.5
Total		87080	94236	-7156	7.6
Test Sites					
Lanes	42.1	9205	3750	5455	145.5
Upper Brace	35.1	3957	5650	-1693	30.0
Squaw	32.9	3035	3468	-433	12.5
Chemung	41.5	8563	9002	-439	4.9
Campau	45.6	14039	14482	-443	3.1
Big Pine Island	33.6	2789	2344	445	19.0
Total		41588	38696	2892	7.5

**1974 Counter Data

[1]Expansion factor used was an exponential function of the following form.

$$y = ae^{bx}$$

y = expanded vehicle entries
a = constant
e = 2.713 (natural logarithm)
b = slope
x = unexpanded vehicle entries

Table 15

Least Squares Correlation of Predicted Use and Observed Use for Test Sites and Survey Sites

	Survey Sites (16)	Test Sites (15)	Combined (Test and Survey) (31)
Region II			
r	.79	.92	.88
r^2	.62	.85	.77
Region III			
r	.96	.84	.96
r^2	.92	.71	.92
Regions II and III Combined			
r	.94	.93	.93
r^2	.88	.86	.86

Sub-hypothesis #2

> The Site Attractiveness Variable will enter significantly in the prediction equation and will be positively correlated with use.

In both Regional Models Attractiveness proved to be positively correlated with use. However, only in Region II does it enter the model significantly at the .10 level. In neither model does this variable have a large effect on the R^2 value. This sub-hypothesis can be accepted as far as the Region II model is concerned, but not in the Region III model.

Table 16

Testing the Study Sub-Hypotheses: Beta Values, Standard Errors of Estimate, and R^2 Change Values for Independent Variables

Variable	β	Standard Error	R^2 Change
Attractiveness (II)[1]	1.661*	1.009	.01
Attractiveness (III)	.4956	.3131	.01
Accessibility (II)	.2497*	.1306	.01
Accessibility (III)	.0725	.0882	.005
Travel Time (II)	-.8642*	.1079	.25
Travel Time (III)	-.8640*	.0743	.49
Acres (II)	.0546	.1396	.08
Acres (III)	.0537	.0806	.01
Population (II)	.5280*	.0533	.17
Population (III)	.00021	.0456	.01

[1]Numerals in parentheses indicate reference model (Region II or Region III).

*Significant at the .10 level of significance.

Sub-hypothesis #3

> The Accessibility Variable will enter significantly into the prediction equation and will be positively correlated with use.

The same comments apply here as were made for the Attractiveness Variable. It is significant at the .10 level only in the Region II model, and has very little effect on the R^2 value in either. The sub-hypothesis is accepted in Region II, not in Region III.

Sub-hypothesis #4

> Visitations to Michigan public access sites are negatively correlated with the Travel Time Variable.

Travel Time enters both models in a negative direction significantly at the .10 level. In Region II this variable explains 25% of the variation, or nearly half of the total explained variation (R^2 = .52). In Region III the Travel Time Variable accounts for 49% of the variation, or nearly all of the total explained variation (R^2 = .53). The sub-hypothesis is accepted.

Sub-hypothesis #5

> The Lake Acreage Variable will have a statistically significant positive effect on site use.

The sign on the coefficient in each Regional model is as expected, but at the .10 level of significance this variable enters neither equation. The sub-hypothesis is rejected.

Sub-hypothesis #6

> The population of the origin concentric zone will have a statistically significant positive effect on site use.

Population has a positive effect on site use in both Regional models. In Region II the Population Variable enters significantly at the .10 level, and explains a substantial portion (17%) of the total explained variation. In Region III population has little effect on the R^2 value and does not enter the equation significantly. The sub-hypothesis is accepted for the Region II model, but must be rejected in Region III.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS

Application of the Models

As the previous chapter indicated, improvement in the ability of the model to predict site specific visitations over the Warner Model seems to have been achieved. However, a glance at Tables 15 and 16 will reveal large individual differences between counter and predicted values at some sites. As in the Warner Model, aggregate estimations appear more accurate than those for individual sites. A closer look at the data reveals that most of the predictions which show high percentage of error are very low-use sites, where a relatively small absolute error will produce a large percentage of error. It was found that the standard error of estimate in each region was approximately 3,000. Sites which saw little use would be expected, then, to show a larger degree of error. A high degree of precision in visitation estimation has not been achieved. However, it is felt that the model is accurate enough to be useful insofar as it predicts relative usage. By viewing data in usage classes established by the Waterways Division, a fair degree of accuracy can be seen.

Of all the sites (test and survey) in the study, counter data indicate that five of these are Class I sites (15,000 or more vehicles annually). Four of these were predicted to fall into that Class. Similar accuracy is shown in Class II sites (5,000 to 15,000 vehicles annually), where 10 of 11 sites so classified by counter data were also predicted to fall into that class. The low use sites show the least accuracy. Class III sites (up to 5,000 vehicles annually) were predicted in 8 out of 13 occurrences to fall into that class.

While many of the predictions show a high degree of accuracy and predictions by usage class are fairly consistent, it should be recognized that application of the models to other inland lake sites in Michigan must rest on the assumption that the sites used in the analysis are representative of all lakes in Michigan's Lower Penninsula. Given the number and diversity of lakes, this assumption could be called into question, and the models should be used with some caution for this reason. Predictions obtained from the models should be viewed in conjunction with experience at other similar public access sites.

Application of the Region III Model should be particularly judicious because the exponential expansion function utilized in that region cannot be justified on theoretical grounds. It is accepted because of its utility in explaining observed variation. Also it should be noted that small variations in unexpanded predictions will result in relatively large differences in expanded predictions. As previously mentioned, the exponential function may be effective in explaining variation because of high "after hours" use of sites which would not be reflected in survey data. The survey design may have resulted in a sample not representative of true use. Potential problems here include: 1) not surveying during late evening hours after the sites were technically closed; 2) surveying only during the summer months--some sites may receive substantial winter use for icefishing, etc; 3) Potential bias introduced during data collection which resulted from heavier scheduled interviewing during weekends rather than weekdays. Another potential problem involves the counters themselves: there may still be inaccuracies in counter data which have not yet been identified by Waterways Division personnel.

Some suspicion must be cast on the Region III Model also because of the lack of statistical significance of all but the Travel Time Variable in the equation. The fact that only the Lake Acres Variable fails to enter the Region II equation significantly suggests some possible differences in the patterns of site visitation and demographic characteristics between the Regions. In Region III, many public access sites are located near medium to large urban areas, a characteristic of none of the sites studied in Region II. Thus, in Region III there are large numbers of people in a position to make an impromptu decision to go to a lake site and act upon that decision immediately. So we see a large amount of usage, most of it originating a short distance from the site. In Region II the pattern is different. Site users are often travelling a much greater distance than the Region III visitor; a decision to travel a greater distance implies more planning. The attractiveness and accessibility of the lake may take on more importance in this situation.

In any study of recreation site visitation it should be expected that some factors affecting the visitation rate will not and in many cases cannot be included in the analysis. Examples of potentially significant factors which cannot be readily quantified are: 1) lack of knowledge of alternative sites by users; 2) habitual use of sites not necessarily optimal for the user; 3) use of sites because of proximity to friends, relatives, or other attractors not readily identifiable.

The variables added in this research, attractiveness and accessibility, would both be expected to have been influential. But they apparently have little effect, and both failed to enter significantly into the Region III Model. A measure of ease of finding a site may have required greater attention. It was learned late in the study that one of the Houghton Lake sites received dramatically higher usage when signs were installed. Also, the expressway system may have been less influential than was assumed in constructing this study's Accessibility Variable. The significance of this variable in Region II suggests that the factors included in the Accessibility Variable were more important to users travelling to the northern part of the state. It may be that highways other than expressways should have received more attention.

Aside from the limitations of the attractiveness measure defined in this study (see Chapter III, Research Methodology), a further problem may be a difference in the perception of attractiveness by users in different parts of the state. It seems reasonable to expect that more attractive sites will receive greater usage than less attractive sites. But the definition of attractiveness may have to be relative. The most attractive lake to users in one area may actually be unattractive to users in an area with a large number of high quality sites. Further, even an unattractive lake in an area with few alternatives to choose from may be subject to heavy use.

Recommendations

With Attractiveness and Accessibility entering one model significantly and not the other, it may be of value to work with these variables further. The comments found in the previous section should lend some direction to this investigation. It would be of particular interest to study the possible relative nature of attractiveness mentioned previously.

The lack of significance of the Population Variable in the Region III model is unexpected. It may be that visitation rates are influenced more by population density than actual numbers of people. As population density increases, for example, the availability of space to store a boat may become limited, lowering the visitation rate from these areas. It may also be of value to look at different population groupings. One example is income level. Warner found that median family income was not effective in explaining variation in site use; but using the median figure may camouflage differences in use patterns between different income groups.

It may be valuable to study differences between weekday and weekend use. Perhaps separate models for each type of use would be appropriate. It is reasonable to expect that the distance travelled to sites is greater on weekends. This may mean that sites in the northern half of the Lower Peninsula, where visitors tend to drive further, would be subject to greater increases in usage during weekends than sites in the southern portion of the state; sites in the southern part of the state might receive relatively more use on weekdays.

It would be of interest to study different user classifications, other than the boater/non-boater distinction used in this study. Finer classification by primary use of the sites, with separate models for each user category, would add complexity, but might also improve the accuracy of prediction.

Finally, the differences in travel patterns between Region II and Region III could be looked at in more detail. The distance travelled to sites in Region II was considerably greater, overall, than the distance travelled to Region II sites. Also, and related to this, many respondents at the survey sites in Region II reported that they had come to the site not from their place of residence, but from a summer cottage or resort. This occurred in almost none of the Region III interviews. In both this study and in Warner's travel times were computed from the place of residence, as if the exclusive reason for the trip was to visit an access site. This is bound to create some distortion of the true picture of site use.

APPENDICES

APPENDIX A

QUESTIONNAIRE SENT TO WATERWAYS DIVISION FIELD PERSONNEL

PUBLIC ACCESS SITE ATTRACTIVENESS STUDY
Michigan State University
Department of Park and Recreation Resources
Recreation Research and Planning Unit

Lake: ____________, County: ____________

1. Approach Road (not entrance road)

   Hard Surface _____
   Gravel, 2 lane _____
   Dirt, 2 lane _____
   Dirt, 1 lane _____

2. Parking Lot

   a. Hard Surface _____
      Gravel _____
      Dirt _____

   b. Number of parking spaces _____

   c. Is there adequate maneuvering space for easy handling of car and trailer?

      yes ___ no ___

3. Ramp

   Hard surface ramp with sufficient water depth to accomodate all trailerable craft (WW code 1) ____

   Hard surface ramp, limited water depth (code 2) ____

   Gravel ramp (code 3) ____

   Area suitable for cartop boats and canoes only (code 4) ____

   Skid pier yes ____ no____

4. Restroom Facilities

   2 Privies _____
   1 Privy _____
   no privy _____

5. Shoreline Type (check any type greater than 20' frontage)

Sand _____
Grass _____
Gravel _____
Timbered _____
Weed/marsh _____

6. Lake Bottom Material at Site

Sand _____
Gravel/stone _____
Mud/silt _____

7. Shoreline footage suitable for recreation: _____feet. (Estimate the amount of shoreline which allows access to the lake, including the ramp)

The following questions require a subjective appraisal of characteristics of the site and the lake. Please read the descriptions carefully and select the category which most closely describes the site. A rough sketch of the site would be helpful.

1. Relative water clarity

Poor _____
Moderate _____
Excellent _____

2. Vegetative Cover (check the description which most closely describes the site.)

A. The following assessment refers primarily to non-boating on-site use. The site should be viewed in terms of its ability to support such activities as swimming, sunbathing, picnicking, etc.

_____ 1) Vegetative cover which is suitable for a wide range of on-site activities, with a large (50' width or more) open area (grass or sand) adjacent to lake.

_____ 2) Suitable for limited on-site activities; limited beach area or heavily shaded; open grass or sand areas not adjacent to lake.

_____ 3) Probably unsuitable for most on-site activities; limited access to lake, little or no open space for non-beach activities.

B. Please rate your impression of the "visual quality": how "attractive" the site is.

highly attractive _____
moderately attractive _____
unattractive _____

3. Shoreline Development

A. Percent of shoreline developed--estimate

0 - 20 _____ 61 - 80 _____
21 - 40 _____ 81+ _____
41 - 60 _____

B. Visual quality (check the description which most closely describes the lake.)

_____ 1) development unobtrusive all around lake: heavy tree or other vegetative cover up to shoreline; rolling terrain are possible considerations.

_____ 2) development somewhat obtrusive, little vegetative cover, moderately attractive.

_____ 3) development very obtrusive, little vegetative cover, relatively unattractive.

4. Ease of Finding Site

Please rate the site according to how easy you think it would be to find for someone who had never been there. Use a relative scale from 1 (very difficult) to 6 (very easy). _____

APPENDIX B

COUNTY RANKING: BOAT LAUNCHINGS PER CAPITA

APPENDIX B

County Ranking: Boat Launchings per Capita*

County	Launch./cap.	County	Launch./cap.
Ingham	.02	Barry	.74
Wayne	.03	Missaukee	.78
Gratiot	.04	Crawford	.79
Kent	.07	Branch	.80
Saginaw	.07	Van Buren	.81
Genessee	.08	Montcalm	.85
Isabella	.10	Gladwin	.89
Shiawasee	.10	Clare	1.08
Clinton	.16	Alpena	1.09
Ionia	.16	Wexford	1.12
Midland	.17	Presque Isle	1.17
Macomb	.17	Antrim	1.21
Oakland	.20	Oceana	1.29
Monroe	.24	Cass	1.32
Lenawee	.26	Cheboygan	1.33
Sanilac	.26	Huron	1.34
Tuscola	.26	Ogemaw	1.37
Washtenaw	.26	Charlevoix	1.44
Eaton	.29	Emmet	1.45
Bay	.30	Mason	1.46
Kalamazoo	.31	Grand Traverse	1.48
Jackson	.32	Newago	1.58
Calhoun	.34	Kalkaska	1.75
Otsego	.36	Iosco	1.89
Osceola	.37	Arenac	2.27
St. Clair	.37	Leelanaw	2.50
Lapeer	.39	Alcona	2.72
Hillsdale	.42	Oscoda	3.05
Ottawa	.49	Lake	3.17
Mecosta	.55	Roscommon	3.35
Livingston	.66	Manistee	3.40
Allegan	.67	Benzie	7.60
St. Joseph	.68		
Muskegon	.70		

*Only counties in Michigan's Lower Penninsula are listed.

APPENDIX C

COUNTY RANKING: LAKE ACREAGE

APPENDIX C

County Ranking: Lake Acreage *

County	Lake Acres	County	Lake Acres
Sanilac	204	Wexford	6788
Huron	243	Otsego	7281
Arenac	326	Gladwin	7294
Bay	435	Van Buren	7489
St. Clair	670	Branch	7831
Shiawasee	815	Montcalm	7904
Eaton	1074	Manistee	8248
Gratiot	1118	Allegan	8522
Clinton	1311	Mecosta	8827
Isabella	1344	Mason	9711
Saginaw	1480	Washtenaw	9755
Macomb	1664	Kent	9974
Tuscola	1799	Emmet	10,412
Monroe	1894	Livingston	10,572
Ingham	1976	St. Joseph	10,575
Midland	2546	Cass	10,944
Ionia	2671	Iosco	10,994
Wayne	2889	Muskegon	11,453
Crawford	2948	Jackson	11,557
Osceola	3482	Kalamazoo	11,740
Oceana	3779	Montmorency	12,100
Oscoda	3840	Newago	12,543
Berrien	4256	Alcona	13,030
Hillsdale	4275	Alpena	13,373
Missaukee	4565	Barry	13,949
Lake	4645	Presque Isle	15,504
Lapeer	5008	Leelanau	17,514
Ottawa	5029	Benzie	17,884
Genesee	5136	Grand Traverse	17,900
Lenawee	5496	Charlevoix	23,415
Clare	5716	Oakland	25,504
Kalkaska	5931	Antrim	30,277
Ogemaw	6136	Roscommon	39,132
Calhoun	6561	Cheboygan	51,358

*Only counties in Michigan's Lower Penninsula are listed.

APPENDIX D

SITE CHARACTERISTICS RELATING TO ATTRACTIVENESS AND COMPONENT SCORES, SURVEY SITES

APPENDIX D

Site Characteristics Relating to Attractiveness and Component Scores, Survey Sites

Site	Road		Parking Lot[1]			
	Surface Material	Score	Surface Material	Maneuver-ability	Space	Score
Austin	paved	10	gravel	ad.	47	8
Orchard	paved	10	gravel	ad.,sp.	60	10
Wolverine	paved	10	gravel	ad.,sp.	20	6
Sherman	paved	10	paved	ad.,sp.	31	8
Fenton	paved	10	gravel	ad.	50	8
Union	gravel	8	gravel	--	10	3
Swan	dirt	5	gravel	--	20	4
Muskrat	gravel	8	gravel	sp.	15	4
Higgins	paved	10	gravel	ad.	50	8
St. Helen	paved	10	paved	ad.,sp.	30	8
Chippewa	paved	10	dirt	--	30	4
Clear	paved	10	gravel	--	10	3
Big Star	paved	10	gravel	ad.,sp.	50	9
Wixom	gravel	8	gravel	ad.,sp.	26	7
Wiggins	gravel	8	gravel	ad.	25	5
Big Twin	paved	10	gravel	ad.	5	4

[1]"ad." refers to adequate maneuvering space on the site, "sp." refers to presence of a launching "spur" at the site.

APPENDIX D (cont.)

Site	Code[2]	Ramp Pier	Score	Rest Rooms Number	Rest Rooms Score	Veg. Cover[3] Score
Austin	1	yes	10	2	10	9
Orchard	1	yes	10	2	10	8
Wolverine	1	no	8	0	0	2
Sherman	1	yes	10	2	10	6
Fenton	1	no	8	1	5	6
Union	1	yes	10	1	5	2
Swan	3	no	4	1	5	2
Muskrat	1	no	8	2	10	1
Higgins	1	yes	10	2	10	5
St. Helen	1	no	8	2	10	8
Chippewa	2	no	6	2	10	5
Clear	3	no	4	1	5	5
Big Star	1	yes	10	2	10	7
Wixom	1	no	8	2	10	7
Wiggins	1	no	8	2	10	6
Big Twin	3	no	4	1	5	5

[2]For an explanation of ramp codes, see page 43.

[3]For an explanation of vegetative cover scores see page 44.

APPENDIX D (cont.)

Site	Shoreline Developed %	Score[4]	Shoreline Footage[5]	Score	Shoreline Type	Score
Austin	90	2	700	10	grass	7
Orchard	80	6	900	10	grass	7
Wolverine	90	2	100	2	bare soil	3
Sherman	60	6	200	4	grass	7
Fenton	90	2	200	4	gravel grass	4
Union	80	5	60	2	marsh	0
Swan	20	8	35	1	marsh	0
Muskrat	0	8	40	1	marsh	0
Higgins	90	7	55	2	grass timber	4
St. Helen	10	9	250	5	sand	10
Chippewa	80	5	300	6	sand	10
Clear	50	6	70	2	gravel	3
Big Star	70	5	125	3	grass	7
Wixom	50	4	350	7	grass	7
Wiggins	80	5	210	5	gravel	3
Big Twin	90	6	65	2	gravel	3

[4]This score is a combination of percent of shoreline developed and the "visual quality" of the shoreline (see page 47).

[5]Footage refers to the length of shoreline suitable for recreational purposes (see page 48).

APPENDIX D (cont.)

Site	Lake Bottom Material	Lake Bottom Score	Fishing Quality[6]	Fishing Score	Water Clarity	Water Score
Austin	sand	10	good	6	mod.	6
Orchard	gravel	7	good	6	mod.	6
Wolverine	sand gravel	8.5	poor	1	exc.	10
Sherman	gravel mud	5.5	very good	8	exc.	10
Fenton	sand	10	good	6	mod.	6
Union	mud	4	good	6	poor	2
Swan	mud	4	good	6	exc.	10
Muskrat	mud	4	very good	8	poor	2
Higgins	sand	10	good	6	exc.	10
St. Helen	sand	10	fair	4	mod.	6
Chippewa	sand	10	very good	8	exc.	10
Clear	sand	10	good	6	exc.	10
Big Star	sand	10	exc.	10	exc.	10
Wixom	sand	10	good	6	mod.	6
Wiggins	sand	10	good	6	mod.	6
Big Twin	sand	10	fair	4	exc.	10

[6]Rated by DNR Regional Fisheries Biologists (see page 51).

APPENDIX D (cont.)

Site	Region Score[7]	Weighted Attractiveness Score Boat	No Boat	Comb.
Austin	6	780	759	775
Orchard	5	792	760	779
Wolverine	5	499	423	457
Sherman	5	828	737	779
Fenton	3	650	582	612
Union	7	492	303	396
Swan	7	474	430	445
Muskrat	2	517	345	427
Higgins	10	804	711	753
St. Helen	10	815	848	832
Chippewa	6	774	799	781
Clear	6	562	581	565
Big Star	8	885	785	830
Wixom	7	727	719	724
Wiggins	7	657	610	633
Big Twin	8	556	581	562

[7]For explanation of Region Score see page 53.

APPENDIX E

SITE CHARACTERISTICS RELATING TO ATTRACTIVENESS AND COMPONENT SCORES, TEST SITES

APPENDIX E

Site Characteristics Relating to Attractiveness and Component Scores, Test Sites

Site	Road Surface Material	Road Score	Parking Lot[1] Surface Material	Maneuver-ability	Space	Score
Lanes	paved	10	gravel	ad.	15	4
Upper Brace	paved	10	gravel	ad.	20	5
Squaw	gravel	8	gravel	--	45	6
Chemung	paved	10	gravel	ad.	30	6
Campau	paved	10	gravel	ad.	35	6
Big Pine Island	paved	10	gravel	--	10	3
Pretty	paved	10	gravel	ad.	10	4
Littlefield	gravel	8	gravel	ad.	16	5
Pratt	paved	10	gravel	ad.	12	4
Cranberry	gravel	8	gravel	--	6	3
Houghton West	paved	10	dirt	ad.	40	6
Houghton East	paved	10	gravel	ad.	40	7
Peach	paved	10	dirt	ad.	20	4
Blue	paved	10	gravel	ad.	10	4
Diamond	paved	10	gravel	ad.	20	5

[1]"ad." refers to adequate maneuvering space on the site. "sp." refers to the presence of a launching "spur" at the site.

APPENDIX E (cont.)

Site	Code[2]	Ramp Pier	Score	Rest Rooms Number	Rest Rooms Score	Veg. Cover[3] Score
Lanes	3	no	4	1	5	4
Upper Brace	3	no	4	1	5	5
Squaw	2	no	6	2	10	2
Chemung	3	no	4	2	10	5
Campau	1	no	8	2	10	8
Big Pine Island	3	no	4	1	5	4
Pretty	3	no	4	1	5	5.5
Littlefield	3	no	4	2	10	5.5
Pratt	1	no	8	2	10	7
Cranberry	3	no	4	1	5	2
Houghton West	3	no	4	2	10	9
Houghton East	2	yes	8	2	10	10
Peach	2	no	6	2	10	5.5
Blue	2	no	6	1	5	5.5
Diamond	1	no	8	2	10	9

[2]For an explanation of ramp codes see page 43.

[3]For an explanation of vegetative cover scores see page 44.

APPENDIX E (cont.)

Site	Shoreline Developed %	Score[4]	Shoreline Footage[5]	Score	Shoreline Type	Score
Lanes	10	9	50	1	marsh	0
Upper Brace	10	7	50	1	marsh	0
Squaw	90	2	50	1	marsh	0
Chemung	100	2	75	2	marsh	0
Campau	90	3	100	2	grass	7
Big Pine Island	70	5	50	1	marsh	0
Pretty	50	5.5	15	1	timber	1
Littlefield	50	5.5	50	1	grass	7
Pratt	90	3.5	40	1	sand	10
Cranberry	70	4.5	20	1	timber	1
Houghton West	90	2	650	10	sand	10
Houghton East	90	2	250	5	grass	7
Peach	30	8.5	295	6	sand	10
Blue	70	4.5	150	3	gravel	3
Diamond	30	6.5	500	10	grass	7

[4]This score is a combination of percent of shoreline developed and the "visual quality" of the shoreline (see page 47).

[5]Footage refers to the length of shoreline suitable for recreational purposes (see page 48).

APPENDIX E (cont.)

Site	Lake Bottom Material	Score	Fishing Quality[6]	Score	Water Clarity	Score
Lanes	muck	4	fair	4	mod.	6
Upper Brace	muck	4	fair	4	exc.	10
Squaw	muck	4	good	6	exc.	10
Chemung	gravel	7	fair	4	exc.	10
Campau	sand	10	good	6	mod.	6
Big Pine Island	muck	4	exc.	10	exc.	10
Pretty	gravel	7	good	6	mod.	6
Littlefield	sand	10	fair	4	exc.	10
Pratt	sand	10	very good	8	mod.	10
Cranberry	sand	10	fair	4	mod.	6
Houghton West	sand	10	good	6	mod.	6
Houghton East	sand	10	good	6	mod.	6
Peach	gravel	7	fair	4	mod.	6
Blue	gravel	7	fair	4	exc.	10
Diamond	sand	10	fair	4	exc.	10

[6]Rated by DNR Regional Fisheries Biologists (see page 51).

APPENDIX E (cont.)

Site	Region Score[7]	Weighted Attractiveness Score Boat	No Boat	Comb.
Lanes	4	433	400	411
Upper Brace	4	477	457	460
Squaw	6	549	456	495
Chemung	6	528	523	519
Campau	4	708	664	684
Big Pine Island	4	153	432	462
Pretty	6	481	450	460
Littlefield	2	621	664	637
Pratt	7	774	721	747
Cranberry	6	428	398	408
Houghton West	10	714	837	776
Houghton East	10	759	758	759
Peach	7	704	760	731
Blue	10	570	568	569
Diamond	9	789	857	825

[7]For an explanation of the region score see page 53.

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