ABSTRACT

A SYSTEMS ANALYSIS AND SPATIAL DEMAND
APPROACH TO STATEWIDE RECREATION PLANNING:
A CASE STUDY OF BOATING IN MICHIGAN

by Michael Chubb

Since World War II, socio-economic changes in North America such as population growth, higher disposable incomes, more leisure time, and increased personal mobility, have resulted in a great surge of participation in various recreation activities. As a result, federal, state, and local recreation agencies have begun extensive expansion of their programs involving large areas of land and considerable financial expenditure. In order to ensure that such assets are allocated in a manner that will produce the maximum desirable benefits now and in the future, many organizations have developed intensive recreational planning programs. Such planning procedures should be based primarily on consideration of the characteristics and spatial distribution of the user populations, recreation destinations and transportation linkages concerned. The methodological approach of geography, therefore, provides a desirable conceptual framework for the research involved in these planning processes.

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The systems analysis - spatial demand computer based approach to recreation planning developed in this dissertation and known as "RECSYS-SYMAP" is considered to be an excellent method since it does represent the spatial distribution of supply and demand and relate them quantitatively. It is also reasonably realistic; can be applied to most recreation activities; uses origins and destinations that are comparatively small in area; is based on specific use statistics; considers user pressures from all origins simultaneously; expresses demand and supply in the same units; is relatively fast and easily repeatable; reduces the effect of personal judgment; produces realistic graphic representations of supply, demand, needs, and surplus; and, once set up, is easy to operate. The complex Michigan recreation system with its many widespread recreation destinations, intricate highway network, and multitude of recreation users from a great variety of in-state and out-of-state origins; can only be adequately represented, evaluated, analysed and planned by a computer based method.

In order to make a practical test of the RECSYS-SYMAP approach to recreation planning, recreational boating in Michigan in 1965 and 1980 was analysed as a case study. Computer printed maps of the spatial distribution of boating supply, demand, needs, and surplus were produced for both simulatio

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both simulations. From these, maps showing the regionalization of these phenomena were developed. They showed that by 1980 the region of high boating demand that was concentrated around the four county Detroit metropolitan area in 1965 will have spread to cover some twenty-eight counties constituting the southern quarter of the State. Regions of very high demand will also appear in Grand Traverse, Cheboygan, Iosco, Roscommon, and Huron counties. The amount and distribution of the supply of boating opportunities is unlikely to change substantially by 1980 and a considerable imbalance between supply and demand will occur throughout the southern half of Michigan. The construction of artificial impoundments is unlikely to satisfy the need for additional opportunities. Other solutions such as revolutionary changes in transportation or large Great Lakes enclosures appear to be the only ways in which the supply of boating opportunities for residents of urbanized southern Michigan can be increased sufficiently to meet the projected demand.

The case study of recreational boating in Michigan showed that the RECSYS-SYMAP technique can be used to indicate a probable future spatial distribution of recreation supply, demand, needs, and surplus and that its predictions are likely to be reasonably reliable if the patterns of re

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patterns of recreation preferences and behavior remain much the same in the future and the estimates of the rate of change in participation used are approximately correct. It also demonstrated the potential of the technique for planning the allocation of resources for all types of outdoor recreation activities and facilities.

This technique is clearly a valuable geographic tool that merits further development to obtain even greater reliability and at the same time simplify its application. In particular, it is a method of making more precise areal analyses of the major components of recreation systems, namely, origins, destinations, and linkages. Use of this approach will contribute much to comprehension of the mechanics of the recreational uses of resources and add greatly to our knowledge of recreational geography of specific areas.

Approved Lawrence M. Sommers

Date July 25, 1967

A SYSTEMS ANALYSIS AND SPATIAL DEMAND APPROACH TO STATEWIDE RECREATION PLANNING: A CASE STUDY OF BOATING IN MICHIGAN

By

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A THESIS

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in partial fulfillment of the requirements
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Department of Geography

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ACKNOWLEDGMENTS

A thesis of this type which brings together information from a wide range of sources can only succeed if the author has the unselfish co-operation of the many agencies and personnel involved. In Michigan such co-operation must be the rule rather than the exception; indeed, unstinting co-operation has been forthcoming from so many sources it is impossible to acknowledge all those who have provided information and assistance. However, all major data sources have been cited in the footnotes.

I am particularly indebted to Mr. Norman F. Smith of the Michigan Department of Conservation, Dr. Lawrence M. Sommers, Chairman of the Michigan State University Department of Geography, and Dr. Leslie M. Reid who was formerly with the Department of Resource Development at the University, for their assistance in arranging the Department of Conservation research fellowship under which the first half of this project was carried out. Dr. Raleigh Barlowe, Chairman of the Department of Resource Development, and Dr. Howard A. Tanner, Director of the Division of Natural Resources, Michigan State University, also contributed substantially by facilitating its completion.

I am greatly indebted to Dr. Lawrence M. Sommers, my advisor and thesis director, for his continuous encouragement and assistance both during the preparation of this thesis and throughout my graduate program. Dr. Milton H. Steinmueller of the Department of Resource Development, a member of my doctoral committee, also sustained and encouraged me with his suggestions and philosophy. I am also grateful to Dr. Ian M. Matley and Dr. Harm J. deBlij for participating in the doctoral committee and contributing to the success of my program in many other ways.

Many state agencies assisted by providing information or services. Special mention must be made of the contributions of Mr. Norman F. Smith and his staff in the Recreation Resource Planning Division and of Mr. Keith E. Wilson and the staff of the Waterways Division, Michigan Department of Conservation. Data was also supplied by the Boat and Water Safety Section of the Law Enforcement Division, the Fish Division, and the Parks Division. I am especially grateful to Dr. J.B. Ellis of the Department of Electrical Engineering at the University of Waterloo and Mr. Allan H. Schmidt, formerly of the School of Urban Planning and Landscape Architecture, Michigan State University for their assistance with the technical details involved in the systems model and computer mapping techniques.

Finally, I am most indebted to my wife, Holly, for assisting with so many aspects of this study including the typing of draft copies, checking calculations and proofreading.

From the foregoing, it is readily apparent that the production of this thesis has depended on the co-operation of many wonderful people. However, it must be strongly emphasized that the opinions and recommendations contained in it are the responsibility of the author alone and are not necessarily in agreement with the views held by the staff of the Recreation Resource Planning Division of the Michigan Department of Conservation.

M.C. June, 1967

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CHAPTER I

INTRODUCTION

The Problem

Background Information

In the past, the relatively low level of demand for outdoor recreation and its comparatively small spatial and capital requirements have made sophisticated statewide recreation planning techniques unnecessary. State, county, and local recreation entities have often been developed on a haphazard basis. Frequently state and county facilities have been located where a legislator or administrator has found a suitable site that could be purchased at a reasonable price. Local parks have been developed on the same basis or on the principle that a certain number of park acres is required per thousand population.

With the present great expansion in outdoor recreation due to the multiplier effects of increased population, more leisure time, higher incomes, more mobility, urbanization, and greater social acceptance of outdoor activities, many state governments face a serious and complex planning problem. They must be able to allocate considerable public funds and extensive natural resources to various types of recreational developments so that the maximum benefits are obtained now and in the future. To do this, the entire recreation system of the state

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of the state must be examined as a whole so that the present and future roles of federal, state, county, and local governments and private enterprise may be assessed and plans for recreation facilities co-ordinated. The federal Bureau of Outdoor Recreation has stipulated that progress towards the production of a statewide comprehensive recreation plan of this type is required before grants for state and local recreation developments can be made from the Land and Water Conservation Fund.

The development of such a plan should be based on the spatial distribution of the locations where recreation[1] can take place (the destinations), the areal distribution of the various potential population sources (origins), and the location of the highways (transportation links) connecting the origins to the destinations. These are all extremely critical factors in determining the probable extent and distribution of future recreation demand. The spatial arrangement of these components in a recreation system has an overriding in-

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[1]The term "recreation" will be used from here on rather than "outdoor recreation." (This has been done partly to reduce the repetitious use of the two words and also because the phrase "outdoor recreation" is not being used as frequently now in connection with recreation planning and administration. No doubt this is due to "outdoor recreation" having gained a connotation that it means recreation in natural areas only.) In this thesis, "recreation" is employed to mean specifically all leisure activities that are likely to be considered in a statewide recreation plan and particularly those activities covered by the twelve groupings listed in Table 1.

fluence that usually transcends the effects of socio-economic factors in the case of most recreation activities. Thus spatial distribution is of the essence in statewide recreation planning and the methodological approach of geography provides a desirable conceptual framework for the basic research necessary.

Since 1960, a number of states have produced statewide recreation plans. A great variety of techniques have been used in these but no really satisfactory method of numerically relating supply to demand in a spatially significant manner has been devised.

In Michigan the Recreation Resource Planning Division of the Michigan Department of Conservation is charged with statewide comprehensive recreation planning. Early in 1965, the Division awarded the author a fellowship to carry out research aimed at developing a suitable planning process for this task since techniques tested had proved to be inadequate. After a thorough investigation of recreation planning methodology it was decided to use a computer systems modelling program to predict the distribution of demand, a spatial demand approach to relate demand to supply, and a computer mapping technique to express the distribution of supply, demand, and needs in a graphic form.

In order to make it possible to use these techniques in at least a general manner for <u>all</u> recreation activities, the recreatio

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the recreation spectrum was divided into twelve activity groupings, namely: driving for pleasure, playing sports, swimming, sightseeing, picnicking, walking and riding, fishing, boating, hunting, camping, winter sports, and attending outdoor events. Tentative spatial standards for each known as "sustained yield capacity standards" were developed based on the number of recreation opportunities a given area of land or water is estimated to offer at one time. From these standards "annual carrying capacity" values were calculated. This value is the number of user-unit recreation use-periods it is estimated a spatial unit can carry in one year assuming average patterns of use. For example, the tentatively adopted annual carrying capacity for picnicking is 1,800 picnic site use-periods per acre per year.[1]

It was clearly impossible to carry out the technique for each of the twelve activity groupings. Instead, it was decided to test the process for one activity. Recreational boating was selected for this case-study for three reasons. First, boating appears to be an activity that is likely to have a participation pattern which conforms to the "normal" concepts of distance decay and destination attraction effects and is little affected by social factors and other variables unique to specific origins. Second, boating is extremely important to Michigan at the present time in view of the

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[1]For definitions of terms used see pp. 147-148.

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high level of participation, the considerable outlay needed for facilities, the frequency of water use conflicts, the economic impact of boat manufacture and tourism, and the probably great increase in boating that will result from the successful development of a Great Lakes salmon fishery. Third, boating happened to be the one activity for which reasonably good use data was available by origin and destination. Such data is necessary in order to calibrate the systems model for the base year.

The Problem

The problem therefore was to test the systems analysis--spatial demand--computer mapping approach to see if it appeared to adequately predict the distribution of demand, relate demand to supply in a numerical manner in order to indicate needs, and show the spatial distribution of these parameters in a significant manner.

The Hypothesis

It was hypothesized that the proposed analysis of the spatial aspects of Michigan boating in 1965 and 1980[1] would test the RECSYS-SYMAP[2] technique that had been developed, and

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[1] 1965 was chosen as the base year because of the availability of reliable use data. 1980 was selected as the date for which projections would be made because it is the target date for all current planning being done under the State Resource Planning Program.

[2] These two abbreviations stand for the county to county recreation systems modelling program (RECSYS) and the computer mapping program known as synagraphic mapping (SYMAP).

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would indicate the probable reliability and potential of this process in planning the allocation of resources for the development of all types of outdoor recreation facilities.

It was further hypothesized that the use of the RECSYS-SYMAP technique in this manner would show quantitatively the probable spatial distribution of boating demand, supply, needs, and supply surplus for these two years.

The Need for a New Approach

In 1965, the Assistant Director of the Bureau of Outdoor Recreation emphasized that the problem of developing an adequate statewide recreation planning process was worthy of widespread research and stated:

> A concerted effort is necessary at all levels of government and by private agencies and universities to improve and refine data and methodology for determining demand and needs. Creative imagination must be brought to bear on the problem.[1]

The lack of adequate methods of determining demand and relating it to supply in order to predict needs has meant that most agencies are still using attendance curve projections or gross participation rates coupled with socio-economic multipliers in order to obtain estimates of future rec-

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[1]Daniel M. Ogden, Jr., Assistant Director, Bureau of Outdoor Recreation, U.S. Department of the Interior, in a letter of transmittal dated March 5, 1965 which accompanied the "Demand" and "Needs" chapters of the Nationwide Plan Manual.

reation demand. In many cases, the participation rates that are used are those contained in the 1962 National Recreation Survey[1] of the Outdoor Recreation Resources Review Commission which is based on data for the period between September 1960 and June 1961. Although these rates have been of considerable value at a national level, their application in estimating demand in individual states is not satisfactory. For example, in Michigan the total sample consisted of only about 120 individuals and thus is statistically inadequate to produce reliable data for the State due to the large number of variables that have to be analysed.

The need therefore is for a new technique that will fulfill the following broad requirements. First, it must be so designed that it will give relatively accurate predictions of future demand in a spatial context. Second, it must quantify the supply of recreation opportunities in the same units as those by which the demand is measured so that the two may be compared and the resultant needs or surplus determined.

In Michigan there is an obvious need for a method that fulfills these two requirements and yet is relatively quick and easy to operate. The Michigan recreation system is com-

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[1]U.S., Outdoor Recreation Resources Review Commission, Study Report 19, National Recreation Survey (Washington, D.C.: U.S. Government Printing Office, 1962).

plex and the staff of the Recreation Resource Planning Division in the Department of Conservation is small. Rapidly changing conditions and the constant proposal of various new recreation developments make intuitive recreation planning methods inadequate. The Division needs an improved planning process that can be readily repeated in order to gauge the effect of proposed new programs and facilities.

Review of Recreation Planning Techniques

Statewide comprehensive outdoor recreation planning really began with the California Public Outdoor Recreation Plan in 1960. Much recreation planning had been carried out previously but generally only one agency or one type of recreation entity had been involved in such plans. There were no attempts to consider all aspects of recreation over large areas.

The California plan was preceded by and partly based on a study directed by a nationally representative committee of recreation specialists which developed A User-Resource Recreation Planning Method.[1] In order to establish "detailed relationships" between user groups and recreation lands, this ap-

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[1]National Advisory Council on Regional Recreation Planning, A User-Resource Recreation Planning Method (Hidden Valley, Loomis, California: National Advisory Council on Regional Recreation Planning, 1959).

proach developes planning guides that are intended for use in the analysis of both demand and supply. These guides are based on the spatial needs of four broad user groupings (sportsmen, family campers, resort users and sightseers) in five broad land classes (natural reservations, natural developed areas, man developed areas, urban land and open space).[1] The recommended procedure involves the application of participation rates for each user grouping by five age and socio-economic classes to the total population of the area serviced. The resultant user-day totals for each user grouping are then converted into a required number of acres by using converting factors. The spatial demand for each land class is compared with the actual acreages inventoried in order to determine the adequacy or inadequacy of the supply.

This planning method is unique in that it does attempt to mathematically relate supply to demand. It has one major shortcoming in that the four user groupings combine too many varied activities and thus can involve many possible combinations of demands on the natural resources of an area. Apparently it has not been tested in a practical application using actual numbers.

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[1] Ibid., p. 74.

The California plan still stands out as an exceptional planning effort although it was the first plan that attempted to consider statewide recreation in such a comprehensive manner. It relates supply to demand for both a base year, 1958, and also for a planning target year, 1980. The plan does not give exact details of how demand was assessed for 1958. It appears that actual visitor counts were combined with agency estimates of attendance and then modified in order to allow for unsatisfied demand which existed at that time "in the judgment of the investigator."[1] In projecting demand to 1980, population increase, leisure time, income, and mobility were considered and values obtained for estimated "day-use" and "overnight and vacation trips" by concentric zones around each county's main center of population. These values were then converted to use estimates for specific activities and changed into estimates of required facilities by using a set of "facility standards" based on each activity's spatial needs.

The California Public Outdoor Recreation Plan is undoubtedly a major milestone in statewide recreation planning. It is particularly noteworthy because of its methods of projecting demand, its comprehensive qualitative approach, its

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[1]California Public Outdoor Recreation Plan Committee, California Public Outdoor Recreation Plan (Sacramento, California: California State Printing Office, 1960), Pt. II, p. 191.

use of detailed information to support broad generalizations, its partially successful attempt to mathematically relate supply to demand, and its analyses on a county and regional basis.

It has some shortcomings especially when the methodology is considered as a possible approach to continuous statewide comprehensive recreation planning. First, some states would have great difficulty in obtaining the detailed base year data required. Second, there appears to have been a considerable amount of "judgment" used both in developing the basic data and in making projections. The methodology makes it impossible to isolate these judgment variables, evaluate their numerical effect, and check these values against new data. Replication of the original process is, therefore, virtually impossible and attempting to repeat it with more recent values would not necessarily give compatible results. Finally, the fact that the techniques used do not identify the recreation destinations of users from a given origin is a serious drawback in using the data to solve specific planning problems.

Perhaps the other most significant plan is the one published in 1966 by the Wisconsin Department of Resource Development.[1] It analyses the demand for sixteen different outdoor

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[1]Wisconsin, Department of Resource Development, The Outdoor Recreation Plan (Madison, Wisconsin: Department of Resource Development, July, 1966).

recreation activities and uses carrying capacity standards in order to relate the facilities available in each county to the facilities which would be required to meet present and future needs.

The Wisconsin plan has three main deficiencies. First, the participation rates used are not entirely observed or recorded participation rates for each specific origin. (The rates used are the regional values developed by the Outdoor Recreation Resources Review Commission but modified on the basis of Wisconsin data wherever possible). Second, the distribution to particular destination counties is based on theoretical flows rather than actual large scale origin-destination studies although some data of this type have been used. Third, it appears that a considerable amount of judgment is involved in the selection of values to be used in certain parts of the technique.

From a careful analysis of these and some sixteen other typical outdoor recreation system planning techniques,[1] the author has arrived at the following general conclusions. First, it is clear that there has been very little uniformity of approach. This is due in part to a great variation of

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[1] M. Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach: Part III - The Practical Application of "Program RECSYS" and "SYMAP" (Lansing, Michigan: Department of Commerce, August 1967), Technical Report No. 13, pp. 22-77.

opinion on the validity of various techniques. Some rely almost exclusively on ORRRC[1] participation rates and other ORRRC techniques while others reject them as not suitable. Second, it appears that not all states are convinced that statewide recreation plans that attempt to quantify and relate supply and demand are necessary or feasible. Third, only the California and Wisconsin plans have been able to go through the entire process of relating supply to demand in a quantitative manner and predicting needs for specific spatial sub-units. Fourth, it appears that some doubtful procedures may be perpetuated because they are relatively easy to apply and their use in several earlier plans has given them respectability.

The Ideal Method

Specifications

From the previously mentioned extensive analysis of existing recreation plans and experience with statewide recreation planning problems, it is suggested that the ideal technique should have the following thirteen features. It should:

1. -be simple yet realistic. (It should resemble reality to the extent that all the main factors that significantly control recreation usage are represented yet it should be as simple as possible

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[1]ORRRC is the commonly used abbreviation for Outdoor Recreation Resources Review Commission.

so it can be easily used and widely understood. Its realism should include representation of the movement of people to recreation entities as a major feature so that demand can be related to supply spatially).

2. -be applicable to all types of recreation activities.

3. -have quite small destination zones if the process is to be realistic and not result in the masking of any significant spatial aspects of the patterns of use.

4. -be structured so that it is possible to identify the origins of users in terms of relatively small areal units in order that differences in population characteristics and participation rates can be represented with reasonable accuracy.

5. -use demand estimation techniques based on the actual measurement of the amount of use at each destination area by users from each origin area. (Where broad participation rates from other locations or rates which are based on inadequate samples are used, the results can be quite misleading. Ellis has questioned the statistical reliability of detailed participation rates given in ORRRC Report 19[1] and it has been shown elsewhere that there are considerable differences in participation rates even between various counties in Michigan).[2]

6. -employ methods for projecting demand that are reasonably reliable. (Forecasts

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[1]J.B. Ellis, "The Description and Analysis of Socio-Economic Systems by Physical Systems Techniques" (unpublished Ph.D. thesis, Department of Electrical Engineering, Michigan State University, East Lansing, Michigan, 1965), pp. 7-8.

[2]Chubb, *op.cit.*, p. 85.

of future events can at the best be only intelligent estimates, but there are steps that can be taken to see that the maximum of established fact and the minimum of intuition are used in making projections).

7. -consider user pressures from all origins simultaneously rather than dealing with each origin and destination separately. (Since the human mind cannot carry out such complicated simultaneous calculations, computer techniques are necessary).

8. -relate demand to supply in a quantitative manner that is of direct value to the user. (For this to be done, supply and demand must be expressed in the same units and this requires that the carrying capacity of land for various activities be known).

9. -have minimal data requirements. (This is difficult because a considerable amount of complex information is required if the technique is to resemble actual conditions. In order to attempt to reconcile these opposites, it is necessary for the ideal process to use data in as efficient a manner as possible).

10. -be relatively fast and repeatable. (One of the major drawbacks with some planning techniques is that they are so elaborate and time consuming that they become a one-time effort to produce <u>THE</u> Plan rather than a continuous planning process from which data are drawn when a report is needed).

11. -utilize a minimum of personal judgment in the process of relating supply to demand and calculating needs and surpluses. (This ensures that lapses of time or changes in personnel do not result in variations in the basic mechanism of the process and make replication

difficult or impossible. Unless judgment is virtually eliminated it is not possible to reliably test a variety of assumptions or hypotheses).

12. -produce information that can be readily put into reports and other documents such as statewide recreation plans. (Ideally, it should produce tables of figures and maps that can go directly into such plans or that the user can take with him to staff or legislative committee meetings in order to substantiate his recommendations. Again a standardized computer technique with an appended mapping program is indicated).

13. -be structured so that the mechanical process of relating supply to demand and calculating needs and surpluses requires a minimum of attention from highly trained professional specialists once it is set up. (Instead, it should be designed so that a relatively small number of technicians can assemble data and make use of it in the process with a minimum of supervision. Thus the professional user is free to concentrate on improving the process, interpreting the results, and recommending appropriate policies).

RECSYS-SYMAP - The Ideal Method

As has been established elsewhere,[1] the RECSYS-SYMAP planning approach comes closer to fulfilling all the previously mentioned specifications than any other approach. The main reasons for this are as follows:

1. The technique is relatively straightforward yet it is more realistic than any other known method. The actual spatial

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[1]Chubb, op.cit., pp. 84-103.

distribution of the individual recreation destinations and origin areas is represented by the distances assigned to the highway links that connect them. Each origin is treated as a separate generator of participants and each destination functions as a separate and unique entity. Each highway linkage is evaluated individually and assigned appropriate values for distance and average speed.

2. It can be applied to most of the twelve recreational activity groupings cited earlier with little or no modification.

3. The use of individual counties as origins and destinations has meant that these are reasonably small spatial units. This is much better than the approach where large regions or broad concentric zones are used as destinations and only major urban centers are designated as origins.

4. The estimation of demand is based on the actual measurement of use at each destination by residents of each origin area during a given base year. Existing variations in participation rates are, therefore, reflected in the base year simulation and thus affect any projections that are made making them more trustworthy. In addition, its realism and ease of replication should make it more reliable than any other known recreation planning technique.

5. User pressures from all origins are considered simultaneously with the attraction and capacity of all the destinations and the characteristics of the connecting highways. Then the model predicts the probable flow of users based on the previous recorded behavior pattern by which the model has been calibrated and tuned. Since interaction between components is one of the inherent features of the RECSYS model it is particularly suitable for representing the spatially complex recreation system of Michigan.

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6. Demand is expressed in the same units as supply so it is possible to relate the two in a direct mathematical manner. The demand can be subtracted from the supply to obtain a value for the surplus supply available or needs (deficit) at any of the destinations.

7. Once the model is designed, calibrated and tested the process is quite fast and is easily repeatable. This will make it possible to test a variety of assumptions and policies and also bring plans up-to-date quickly when new information becomes available.

8. Since the basic processes involved in the RECSYS analysis are fixed by the mathematical design of the model, the user is not faced with the problem of making continual personal judgments on where recreation participants are likely to go and the resultant relationship between supply and demand.

9. The output from the technique in the form of computer tabulations and SYMAP graphic representations of the areal distribution of these data are readily usable in publications and for visual aids.

10. Due to the fact that the tested RECSYS-SYMAP process is in the form of a fixed computer program, most of the compilation of data and the running of the program can be carried out by technicians thus freeing the user to carry out the more significant functions mentioned earlier.

The RECSYS-SYMAP approach was selected because of these advantages. The biggest problem appears to be the relatively large data requirements but this is a problem common to all the really comprehensive statewide recreation planning processes.

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The Michigan Recreation System

One reason why a fairly sophisticated method of state-wide comprehensive planning is required in Michigan is the complexity of the State's recreation system. This complexity is caused by the large number of origins, destinations, and connecting transportation links involved.

Origins

Although the majority of the recreation users come from the urban centers scattered through the southern portion of the State, a surprising number come from adjacent states--particularly the urban areas in Wisconsin, Illinois, Indiana, and Ohio. In 1964, 27.2% of the total camper days and 15.9% of the total day-use at Michigan State Parks were attributed to visitors from other states.[1] Residents of the Chicago-Gary area are heavy users of Michigan's state parks and fishing waters particularly along the western shore of the Lower Peninsula. Visitors from the Cleveland metropolitan area and other urban centers in Ohio are well represented at recreation entities in southeastern Michigan and further north.

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[1] Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study (Lansing, Michigan: State Resource Planning Program, Michigan Department of Commerce, June, 1966), Vol. II, pp. 7.73 and 8.91.

The populations of these out-of-state urban origins and those within Michigan are growing fast. It is anticipated that Michigan's 1965 population of 8.2 million will have grown to 9.9 million by 1980 and may reach 13 million by the year 2000.[1] Urbanization of the southern four tiers of counties has already resulted in twelve counties becoming major generators of recreation participation and it is anticipated another seven will enter this category by 1980.

Destinations

The recreation destinations are also numerous and widely dispersed. The State has an extensive irregular shoreline and 5,500 scattered lakes which provide the resource base for many activities particularly boating and fishing. Approximately two-thirds of the total U.S. Great Lakes shoreline and water area is within Michigan giving the State 3,288 miles of frontage and 38,575 square miles of water surface area on these prime recreation attractions.

Some 2.2% of the land surface of Michigan is occupied by its 5,500 inland lakes of 10 acres and over in size which total 802,000 acres.[2] These are widely distributed in the

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[1]Michigan Department of Conservation, _Michigan's Recreation Future_ (Lansing, Michigan: Michigan Department of Conservation, September 1966), p. 6.

[2]_Ibid._, p. 4.

State except for the comparatively "lakeless area" southwest of Saginaw Bay. This large number of well distributed lakes is related to the State's glacial history. During the final stages of the Pleistocene Epoch, glaciers extending over the area presently occupied by the Great Lakes thrusting lobes over areas that are now dry land. These lobes repeatedly advanced and retreated. In doing so, they deposited a great variety of morainic materials over much of Michigan. Pieces of ice in this debris melted and left the characteristic "pot-hole" lakes seen in a number of counties. In other instances, glacial materials blocked drainage and created lakes.

In the case of Michigan's "lakeless area", the absence of such a well developed glacial topography has meant very few lakes. This is due to the fact that during the final glacial stage, a glacial lobe extended down the Saginaw Bay depression. Its advances and retreates developed the moraine topography present today in south central and west central Michigan. Finally, a more pronounced retreat occurred and a portion of glacial Lake Arkona covered the Saginaw valley in front of the ice and drained through the Grand River Valley to Lake Chicago and the Mississippi system.[1]

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[1]Jack L. Hough, Geology of the Great Lakes (Urbana, Illinois: University of Illinois Press, 1958), pp. 284-296.

A succession of post glacial lakes covering approximately the same area followed until the ice finally retreated and the water levels fell back to more closely resemble the present levels of the Great Lakes. The result was a large area with comparatively few low slender moraines and many depressions largely filled by lacustrine deposits. A number of reasonably efficient drainage systems were able to re-establish themselves and the arrangement of the moraines did not result in the permanent blocking of drainage and the establishment of lakes.

In contrast, this "lakeless area" in the Saginaw Valley and south central Michigan is surrounded on two sides by interlobate moraines formed by the substantial depositions of material that occurred along the edges of the glacial lobes. In the northern part of Lower Michigan, a succession of various glacial influences has left an even more complex and uneven topography. These two interlobate areas and the northern complex area have many locations where drainage has been blocked by moraines and permanent lakes formed. In other instances, glacial depressions or pot-holes were not filled with extensive lacustrine deposits by late post-glacial lakes and thus remain as permanent bodies of water.

These three highly glaciated zones contain large numbers of lakes and therefore contribute substantially to the supply of recreation opportunities in the Michigan recreation system. The glacial history of these areas has also resulted in a preponderance of poorer sandy soils which in many cases have proved unsatisfactory for agriculture and been established as permanent state and national forests. In addition, glacial history, lacustrine activity and a westerly prevailing wind have resulted in Michigan being blessed with a extraordinary number of excellent sand beaches and dunes on the Great Lakes. This is particularly true of the western side of the Lower Peninsula where the finest stretches of fresh water sand beach in the world are located. Finally, glacial activity in these three zones has provided the much needed physical relief which has made the development of a thriving ski industry possible and added greatly to the aesthetic qualities of the landscape. This combination of predominately glacial originated physical features has given Michigan the outstanding recreation resource base on which its extensive recreation system is founded.[1]

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[1]Michigan has 68 state parks, 3.7 million acres of state forests, 2.5 million acres of federally owned national forest land, a 134,000 acre national park, two national wildlife refuges totalling 100,000 acres, 255,000 acres of state game areas and many other tracts of public lands well scattered through the state. Much private land is also used extensively for recreation.

Highway Links

The Michigan recreation system is also blessed with an extensive highway network which readily permits travel between origin areas and destinations. Frequently a number of alternative routes are available to drivers and most citizens have a considerable range of recreation opportunities open to them within a few hours travelling time.

This highly developed road system coupled with the large number of widely dispersed recreation origins and destinations results in an extremely complex recreation system. Only a planning process that considers the State as such a complex system can begin to relate recreation demand to supply in a spatial context.

Component Modelling

When the author began work on the development of a statewide comprehensive recreation planning process in June 1965, the systems analysis approach had been tested to a limited extent on the projection of state park camper attendance at selected parks. The technique was developed by Dr. Ellis while working on the Michigan Outdoor Recreation Demand Study.[1]

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[1] Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, op.cit., pp. 6.1-6.34; and

Jack B. Ellis, "The Description and Analysis of Socio-Economic Systems by Physical Systems Techniques", op.cit., pp. 6.-33.

Since the model developed for that study was designed to simulate the flow of campers from origin counties to 55 state parks that had substantial camping use, it was not suitable for statewide comprehensive planning purposes. It was therefore necessary to re-design the systems model so that all origins and recreation destinations could be adequately represented. It was decided to use counties as both origins and destinations.[1]

Computer capacity limitations made it impossible to use all 83 counties as origins and destinations if the program was to be able to be run straight through the computer without having to use memory tapes. This would increase running time and costs so that users would not be as willing to make several runs to test hypotheses or suggested plans.

Origin Selection and Designation

In order to reduce the number of counties used as origins, certain counties were paired. Several factors were taken into consideration in selecting the counties to be combined. First, it was decided to avoid crossing Department of Conservation District boundaries so that tabulations could

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[1]Jack B. Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach: Part I - A Manual for "Program RECSYS" (Lansing, Michigan: State Resource Planning Program, Michigan Department of Commerce, May 1966), Technical Report No. 1.

always show District totals. Therefore, counties could only be paired within Districts. Second, it was obviously not desirable to combine major origin areas in order to preserve as much of the individual participation characteristics as possible. An effort was also made to avoid large counties even if the populations were small because the production of very large origin areas would result in too great distances from the edge of the combined unit to the node through which the demand pressure is assumed to act. Therefore, small rural counties with relatively low populations were selected for pairing whenever possible. Six areas were selected as out-of-state origins. These were Illinois, Indiana, Minnesota, Ohio, Wisconsin, and Ontario.

The next step was to select nodes through which the population's demand at each origin was assumed to act. Where the origin unit had one well defined urban center, its center was designated as the origin node. Examples of this are the centers of the cities of Jackson and Grand Rapids which were selected as the origin nodes for Jackson County and Kent County respectively. Where two or more urban centers lie in separate parts of a rural county, a point between them was selected based on the relative populations of these centers.

Destination Selection and Designation

As in the case of the origins, all 83 Michigan counties could not be used as destinations because of computer capacity limits so the number was reduced to 72 by pairing counties with basically similar recreation characteristics. All pairing was again kept within Department of Conservation District boundaries so that destination data can be aggregated by District. No counties with shoreline on the Great Lakes were paired since they are so significant as recreation destinations. An attempt was also made to avoid combining inland counties which have large water bodies or several major state parks or other very highly used facilities. This means most of the pairs are the smaller inland counties with fewer major recreational attractions and recreation resources fairly evenly distributed between the counties in each pair.

The next problem was to select an appropriate destination node in each county or pair of counties which could be considered to be the point through which user pressure is dissipated at that destination. The point selected was generally the place in the county which appeared to be central to the recreation resources of the county.[1]

Highway Link Selection and Calibration

The highway linkages selected for the systems model were generally the most direct interstate or state highway routes

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[1]Chubb, op.cit., pp. 109-117.

between adjacent nodes.[1] The distance assigned to each link was obtained from the official Michigan Department of State Highways map of the state. The traffic speeds assigned to these links are a little on the conservative side in order to allow for the effect of heavy flows during busy weekends and to recognize that many users travel at reduced speeds due to trailers or heavy equipment loads.[2]

The Grouping of Activities

Before proceeding to apply the RECSYS-SYMAP process to statewide recreation planning in Michigan, it was necessary to develop satisfactory groupings of outdoor recreation activities. The prime objective in making these groupings was to produce the fewest possible activity groups that would adequately cover the entire spectrum of significant outdoor recreation activities undertaken in Michigan. The reason for aiming at as few groupings as possible is the time and problems involved in obtaining data, converting it into a usable form and running the RECSYS-SYMAP process. What is needed in

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[1]Only highways have been used as transportation links. It is recognized that some recreation entity users travel by train, boat, or plane but this use is presently very small in comparison to the use by those travelling in automobiles.

[2]Jack B. Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., pp. 5-7 and 65-69; and
Chubb, op.cit., pp. 117-118.

statewide comprehensive recreation planning is a good impression of the overall recreation situation and the changes that are taking place in it.

A number of approaches were tested including groupings on the basis of user classes (day-users, fishermen, etc.) and groupings based on the type of visit involved (urban day trip, rural day trip, etc.) Since none of the new groupings appeared to be entirely satisfactory, it was decided to use conventional activities but to group them wherever possible. The activity classification used in the Michigan Outdoor Recreation Demand Study was used as a starting point. It contained twenty-two outdoor recreation activities. These were reduced to twelve pertinent activity groupings by eliminating some activities and arranging the remainder in groups which generally have similar resource requirements or that can be measured in the same types of use measurement units (see Table 1).

The Development of Capacity Standards

With the activities classified into twelve groups, the next step was to develop reasonable annual carrying capacity standards[1] for each group. These standards are an attempt to

[1]See Appendix I, A Glossary of Terms. This term and the concepts on which it is based are developed in the author's M.S. thesis, "Outdoor Recreation Land Capacity: Concepts, Usage, and Definitions," (unpublished M.S. thesis, Park and Recreation Administration, Department of Resource Development, Michigan State University, East Lansing, 1964).

Table I. Recreation Activity Groupings
(In Descending Order of Participation Predicted by 1980)[1]

Activity Name	Activities Included in Group
Driving for Pleasure	Highway, county road, parkway or street driving for pleasure (166,074,647)
Playing Sports	Active participation in all types of outdoor sports, games, races and competitions (90,303,000)
Swimming	Swimming, paddling, beach play and sun bathing, skindiving (78,925,421)
Sight-seeing	Viewing scenic sites, nature museums, historic sites; urban sight-seeing (51,303,469)
Picnicking	All types of picnicking: Family, group etc. (42,390,037)
Walking and Riding	Walking for pleasure, hiking, nature hikes, horseback riding (39,944,689)[2]
Fishing	Shore, stream, pier, boat, ice (32,811,608)
Boating	All types of boating, water skiing, sailing, and canoeing (19,271,702)[3]
Hunting	All types. Small game, big game, water fowl, etc. (13,604,178)
Camping	Tent, trailer, group (5,049,053)
Winter Sports	Skiing, tobogganing, snowshoeing, skating (not available)
Attending Events	Participation as a spectator at outdoor events of all kinds (not available)

[1]Activities arranged in order of total statewide activity days (figures in parenthesis) predicted from ORRRC data.

[2]Code 06 figure includes ORRRC activities "hiking on trail with pack," "nature walks" and "horseback riding."

[3]Code 08 figure includes ORRRC activities "boating other than sailing and canoes" and "water skiing." A detailed description of the various activities is given in Appendix III of Michael Chubb, <u>Outdoor Recreation Planning in Michigan by a Systems Analysis Approach: Part III - The Practical Application of "Program RECSYS" and "SYMAP"</u> (Lansing, Michigan: Department of Commerce, August, 1967), Technical Report No. 13.

express the spatial and resource needs of the various activites in a quantitative manner. Ideally, these standards should have been developed from actual field studies, but this was not possible due to staff limitations and time constraints. Instead, standards were developed by modifying those used by the Parks Division of the Michigan Department of Conservation and other agencies.[1]

The Case Study

Once the basic design of the RECSYS-SYMAP statewide comprehensive recreation or planning process had been set up and some computer runs carried out to check the technical aspects of the two programs, the next problem was to select one of the twelve activity groupings and proceed completely through a test run of the entire process. It was decided to use recreational boating in Michigan as the test case for reasons described earlier.[2]

A number of facts attest to the significance of boating in Michigan. The State has now drawn ahead of New York State and has the largest number of registered boats of any state. At the end of 1965, there were 399,000 registered boats in Michigan and at least another 50,000 row-boats and other craft

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[1] Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, *op.cit.*, pp. 123-146.

[2] *Supra.*, p. 4.

that did not require registration. Participation in boating also appears to be significantly higher than the national and regional averages.[1] The number of persons from out-of-state origins who come to Michigan primarily to engage in recreational activities involving boating is also considerable.

The remainder of this thesis will discuss the techniques and problems involved in conducting this first practical test of RECSYS-SYMAP. The problems associated with the collection and compilation of the necessary data will be discussed before describing and analysing the test itself.

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[1]Chubb, Outdoor Recreation Planning by a Systems Analysis Approach, Part III, op.cit., p. 14.

CHAPTER II

DATA COLLECTION AND PREPARATION

Review of Available Boating Demand Data

Two sources of detailed information on boating demand by origin and destination were found to be available. They were the 1964 Recreational Boating Survey of the Michigan Outdoor Recreation Demand Study and 1966 Boating Needs Survey of the Waterways Division of the Michigan Department of Conservation.[1] It was decided to use the data on boating in 1965 from the Waterways Division survey in the RECSYS-SYMAP simulation because it has several significant advantages.

The first advantage is that the Waterways Division sample was somewhat larger than the MORDS[2] sample. A total of 13,670 questionnaires were mailed of which 9,444 were sent to owners of registered boats under 20 feet in length and 4,226 went to owners of boats over 20 feet. This stratification was done in order to obtain an adequate sample in the over 20 foot

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[1]Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, op.cit., Vol. II, pp. 10.4-10.7; and

Michigan Department of Conservation, Waterways Division, Transportation Predictive Procedures: Recreation Boating and Commercial Shipping (Lansing, Michigan: Department of Commerce, April 1967, Technical Report No. 9C). pp. 23-29.

[2]MORDS is the commonly used abbreviation for Michigan Outdoor Recreation Demand Study.

class which contained a much smaller number of boats. A total of 5,218 usable questionnaires were returned. The MORDS study was based on the analysis of 3,566 usable returns from a mailing of 9,902 questionnaires but was not stratified by boat length so the data for larger boats may be somewhat less statistically reliable. Both samples were stratified by county and the respondents selected randomly in each county in proportion to the number of registered boats in that county.

The second big advantage of the Waterways Division data is that they are based on a more straightforward series of questions regarding use. The questionnaire only required the respondent to indicate the three counties in which most boating was done together with the number of days or part days spent boating in each of these counties and the aggregate number of days or part days spent boating in all other counties. Other questions identified the respondents county of residence by name and determined whether the boat concerned was in the under 20 foot or over 20 foot class.[1] The use questions were designed specifically to provide base year use data for the RECSYS-SYMAP study.

In contrast, the MORDS survey asked the respondents to use a numbering system to identify counties of origin and des-

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[1]Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit., gives more details of the questionnaire.

tination. Unfortunately, a typing error resulted in one county being wrongly numbered which made certain responses ambiguous. Another drawback was that the respondents were requested to indicate the percentage of their total 1964 boating time spent in the three counties they had used most. Some respondents clearly had difficulty comprehending this concept and it is probable that others may have not given as reliable answers as should have been obtained from the more direct Waterways Division questions. The number of boat use-periods in a particular county was computed by applying the appropriate percentage to the respondent's estimated number of days spent boating during the year which had been given in response to another question.

The positive features of the Waterways study and the negative aspects of the MORDS survey made it appear advisable to use the former for the RECSYS base year. However, this MORDS data had been aggregated and expanded at an earlier date and will be cited later as a check.

Both studies had some features that were not entirely satisfactory but which would have been difficult to improve. Both asked the respondent to answer the use questions for the boat used most often. This would mean that a considerable amount of use in second or third boats is not included in the data for the sample boaters.[1] However, this error is probably more than cancelled out by the fact that during the expansion of the sample data to give estimated total statewide use, these additional boats were in effect considered to be used as much as the average "most used" boat. A second problem common to both surveys is that only owners of registered boats could be included in the samples. The owners of illegally unregistered power boats and those who own row boats and sail boats without auxillary power were not included unless they also had a registered boat. The MORDS study showed that 13.3% of registered boat owners had one unregistered boat, 2.4% had two such boats and .8% had three or more.[2] Applied to the 1965 estimated registered boat total of 398,902, this would mean the registered boat owners above could be expected to have some 88,000 boats not requiring registration. No reliable estimate of the number of boats not requiring registration which are owned by persons not owning a registered boat was discovered. It is also a problem to know how much boating is done in these unregistered boats. One suspects that many of them are used for fishing and see much service from lake

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[1]The MORDS report showed that 22.7% of registered boat owners in the sample owned two registered boats, 4.1% owned 3, and 1.6% owned four or more. Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, _op.cit._, p. 10-11.

[2]_Ibid._

front summer residences during the summer season. On the other hand, many are probably kept at such residences but see little service due to a decline in interest in fishing or a decline in fishing quality. As will be explained later, it was decided to be conservative and assume that the unregistered boats amount to some 15% of the total number of registered boats and that they receive two-thirds as much use.

A number of other sources were investigated to ascertain if any better use data were available or if information that substantiated aspects of the existing use surveys could be obtained.[1]

Expansion of In-State Use Data

In order to obtain values for the estimated total boating use by registered boat owners by origin and destination it was necessary to expand the values obtained in the surveys. In the case of the MORDS boating survey this was a complicated procedure due to the fact that the responses to three questions had to be simultaneously considered in order to determine the origin and the number of boat-use periods to be assigned to each destination. In the case of the Waterways Division study, the procedure was simpler but had to be done in two separate sets of caluclations due to the straitification by boat size.

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[1]Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

In both cases a computer program carried out the expansion to estimated statewide values at the same time as the analysis was made by origin and destination. Appendix II compares the 1964 and 1965 expanded values by origin. Although there appears to have been some fairly substantial increases and decreases in the amount of boating use generated by some of the origins, the percentage of the total statewide use from each origin is quite similar. This similarity in the pattern of use indicates that both studies are probably reasonably reliable although there were differences in the methods used.

The right hand column in Appendix II gives the 1965 participation rate in average boat use-periods per capita for each in-state origin and was calculated by dividing the expanded boat use-periods by the 1965 estimated population. The great variation in the rates is not entirely due to residents at one origin having a greater propensity to boat than residents of other areas. Part of the difference is due to the problem of owners registering boats in counties other than their county of permanent residence. For example, in the case of Roscommon County, it is hypothesized that the very high participation rate of 14.98 boat use-periods per capita per year is partly due to the fact that many boat owners living elsewhere register their boats in the county because they keep them there permanently at summer resi-

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dences or bring them in at the beginning of each season. Since these people are only summer residents, they are not included in the county's population estimate and hence an exaggerated participation rate results.

This problem of the county of residence not being the same as the county of boat registration also has an effect on the total number of boat use-periods at some destinations that are attributed to certain origins. For example, it is probable that some of the boat use-periods shown in Appendix II as being undertaken in Roscommon County did not take place because the total of the boat use-periods from Roscommon in Roscommon indicated by the sample was multiplied by the number of registered boats for that county. Since some of the boats registered in Roscommon were undoubtedly owned by Wayne residents it would possibly be more accurate to shift these registrations over to Wayne before calculating the expansion. As Wayne must have a somewhat lower true participation rate for boating in Roscommon, this would reduce the Roscommon total boat use-periods to some extent. However, there may be some tendency for such errors to compensate for one another so the total effect may not be a major warping of the data. In future studies on boating use, it should be possible to avoid this problem by asking for both the county of residence and the county of registration.[1]

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[1] Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

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Once the sample data had been expanded in proportion to the number of boats registered for each origin in order to give total estimated participation by origin and destination, it was possible to have data processing cards punched for the origin loading deck and the base utilization deck (see Appendices IV and V respectively). The origin loading deck simulates the user pressure at the origin which results in the flow of users along the highway linkages to the destinations. The base utilization deck is used in the RECSYS program to provide a standard by which to measure the accuracy of the model in predicting use at the destination as will be explained later.

The Problem of the Out-of-State User

As was demonstrated earlier, participation by non-residents accounts for a significant portion of total recreational activity in Michigan. It had been hoped that it could have been possible to include a sampling of out-of-state users in the Waterways Division survey. A few non-resident registered boat owners would have been included in the random sample except that the Division decided to reject these and substitute owners who were Michigan residents. However, the vast majority of out-of-state residents who boat in Michigan do not register their boats in Michigan and hence would not be represented. It appears that only by special surveys of out-of-state boaters

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either at the destinations or at main highway exits from the state, will it be possible to obtain a reasonably reliable estimate of non-resident use.

Since it was impossible to secure reliable statewide out-of-state user data by origin and destination, it was decided to calibrate the RECSYS model for boating done by boats registered in Michigan using the Waterways Division survey values and then add estimates of non-resident use developed from certain indications of its possible magnitude. None of these indicators is particularly reliable mainly because the values all apply to specific areas and should not be applied on a more extensive basis. However, it appeared essential to provide some indication of the probable amount of boating done by boats not registered in Michigan.

The four sources of information which have some quantitative indication of out-of-state use are as follows. First, there are special traffic studies undertaken by the Michigan Department of State Highways where origins, destinations, vehicle types and trip types are investigated by interviewing samples of highway traffic at certain selected points. Since the vehicle classification system used includes three types of vehicle-boat combinations, it is possible to determine what percentage of the boat carrying vehicles are from out-of-state origins and where these vehicles were going but no data on actual boat use is included.

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The second source is information obtained by the Waterways Division concerning the origin, destination, length of cruise and number of larger boats using marina facilities at nine Michigan harbors that have facilities partially financed by the Division. The third source is data on out-of-state fishermen gathered by the Fish Division of the Department of Conservation during special creel censuses. The fourth source is the records on camper registration at Michigan State Parks where the origins and destinations of the campers are known and information has also been gathered on whether or not campers had boats and if such boats were used to sleep in while moored. The exact methods used to develop indicators of the extent of out-of-state boating are described elsewhere.[1] The additional boating use pressure assumed for the six out-of-state origin areas were added through the appropriate nodes (see Appendix VI) and used in the final runs of the 1965 simulation as described in Chapter III.

Boating Supply Data

There are two principal sources of information concerning the supply of water resources in Michigan. One is the

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[1]Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

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series of Lake Inventory Bulletins produced by Dr. C.R. Humphrys of the Department of Resource Development, Michigan State University and the other is the Michigan Lake Inventory undertaken commencing in 1965 by the Recreation Resource Planning Division and field staff of the Department of Conservation. It was decided to use the latter as a basis for the preparation of data on the supply of boating opportunities because it was more recent and also was based on opinions and field checks of Department of Conservation personnel at each District office. (The Humphrys data was largely compiled from the study of readily available maps). It was proposed to use the Lake Inventory in two ways. First, the information on lake acreage would be used to calculate actual boating capacity, and second, some of the other variables inventoried would be utilized in order to calculate attraction indices.

The methods employed in this first task were quite simple. It had been intended to be somewhat selective and eliminate areas that were of little value for boating during the main boating season due to shallow water. This was not possible because the Department was unable to provide detailed county summaries of water areas by the various depth classes. Instead the total acreage of lakes in each county was taken directly from a computer print-out summary prepared by the

Department.[1] These values were then multiplied by the adopted annual carrying capacity of 72 boat use-periods per acre per year in order to obtain the estimated annual carrying capacity of each county's inland lakes. (see Appendix VII).

The acreages given in the inventory included major ponded areas on rivers as well as natural and artificial lakes over five acres in size. Unfortunately, it does not include the acreage of rivers and streams other than ponded sections. In some counties this may be quite a significant omission such as in the case of the AuSable River or certain portions of the Grand River. It is desirable that future inventories include data on the more significant stretches of boatable water along streams and rivers.

Measurement of Great Lakes Boating Water Areas

Since the Michigan Lake Inventory only included inland lakes it was necessary to obtain some estimate of the supply of recreational boating opportunities provided by Great Lakes waters. No source of such information was available so it was decided to attempt to develop the necessary data as part of this study.

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[1]Michigan Department of Conservation, Recreation Resource Planning Division, "Michigan Lake Frontage 1965," unpublished computer print-out dated October 26, 1966.

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An accurate estimate of Great Lakes recreational boating capacity for Michigan's forty-two shoreline counties can only be obtained by careful field surveys involving the recording of actual boating use and the effects of weather conditions. Since such surveys were not within the scope of this project, it was decided to use an office compilation technique based on interpretation of Michigan Department of Conservation county maps. After discussing at length the characteristics of the Great Lakes area adjacent to each shoreline county with Mr. Keith Wilson, Director of the Waterways Division and with Mr. Merle Keller of the Fish Division, it was decided to attempt to zone these areas according to their estimated ability to sustain boating. This was done by setting up three zones.

Zone A was designated as areas that would generally be safe for the majority of boats less than twenty feet in length during 70 to 75% of the three month summer boating season. This zone was assigned an annual carrying capacity of 54 boat use-periods per acre per year which is 75% of the inland lake value. Zone B was said to be generally safe for the majority of boats under 20 feet in length for up to 25 or 30 percent of the 3 month summer boating season and was assumed to have an annual carrying capacity in proportion--namely 20 boat use-periods per acre per year. Zone C was said to lie beyond Zone B and is the area of the Great Lakes that is used to only a very limited extent by the majority of boats under 20 feet due to the distance to shore and usual rougher water conditions. The use of this zone was assumed to be limited by these constraints to about one percent of the use possible in Zone A so the annual carrying capacity was set at .5 boat use-periods per acre per year.

Generally Zone A consisted of well sheltered waters lying in deep bays to the leeward of a major headland or in between a collection of islands. Zone B was considered to generally be waters that lie within 2 1/2 miles of the Michigan mainland. However, in sections of the north part of Lake Michigan and along the exposed parts of the Lake Superior shoreline this was reduced to 1 1/2 miles due to the speed with which hazardous water conditions can develop. Zone C was considered to lie outside Zone B and be of equivalent width so it was generally 2 1/2 miles wide narrowing down to 1 1/2 miles along the sections of shoreline mentioned above.

These zones were indicated on the county maps with colored pencil and then their respective areas in each county were measured using a dot grid planimeter. The acreage for each zone was multiplied by the previously mentioned annual carrying capacity standard and the results tabulated (see Appendix VII).

At first sight it may appear that the boating potential of the Great Lakes areas is greatly exaggerated by this technique when one sees the comparatively small amount of use that is presently made of them. It must be remembered, however, that at present the majority of boat users are using Zones B and C for cruising only. The water is generally too choppy for water skiing and the fishing is good in only a few isolated spots. Fishing is still the primary reason for the majority of people going boating and if an excellent salmon fishery in the Great Lakes does develop we can expect to see a much greater utilization of the 51 million boat use-period potential of the B and C zones.

Development of Attraction and Capacity Indices

The development of adequate attraction indices for the various destinations of the RECSYS model is a problem worthy of a separate thesis. Indeed, VanDoren did produce a dissertation solely on the development of attraction indices for the systems model simulation of state park camping.[1] In that case, the problem was somewhat simpler than for statewide

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[1]Carlton S. VanDoren "An Interaction Travel Model for Projecting Attendance of Campers at Michigan State Parks: A Study in Recreation Geography" (unpublished Ph.D dissertation, Department of Geography, Michigan State University, East Lansing, Michigan, 1967).

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boating in that the destinations were fewer, only the attributes of the actual park site were considered, these attributes were comparatively easily identified and measured, and the behavior and preferences of campers had already been quite extensively investigated. In contrast, all of Michigan's water area on a county by county basis had to be considered in developing a boating attraction index and there are no known studies of boat user preferences other than those concerning docking or launching facilities.

It became clear that it would not be possible to undertake an extensive side investigation into the various aspects of boating attraction. Instead, it was decided to proceed as Ellis[1] suggests and an intuitive approach was used to develop crude indices which were then defined and adjusted during the fine-tuning of the model.

In an initial approach to the intuitive development of attraction indices it was intended to use data from the Michigan Lake Inventory cited earlier. A form was designed which would have rated each destination county on the basis of size of lake, percent of warm shallow lakes (pan fish), percent of two story lakes (game fish), percent of trout

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[1] Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., p. 38.

lakes, percent of lakes with medium fishing quality, percent of lakes with good fishing quality and percent of private recreational-residential shoreline but the data was not available in time.[1]

In an effort to try and discover any direct relationship that might exist between major attributes of the destinations and the volume of boating use, a series of comparisons was made. A number of pairs of counties was selected where both were approximately equidistant from a major population center. The boating use values at these two destinations from that population center were obtained from the print-out of the Waterways Division boating survey summary and compared. For example, the boat use-periods generated by Wayne County in Crawford County (8,114 boat use-periods) were compared with the value for Wayne boating in Roscommon County (63,948 boat use-periods). This is a ratio of one to eight and appears to be tied to the ratio between the water area in each county of one to sixteen (2,491 acres to 39,089 acres). Several pairs of counties were found to show a similar relationship between water acreage and boating use. However, many pairs showed no such relationship or a completely inverse relationship. For example, Otsego County had 40% more

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[1] The Michigan Department of Conservation experienced great difficulty in obtaining county summaries of all the various phenomena inventoried due to the large number of data processing cards involved and the complicated tabulations required.

boat days from Wayne than Montmorency County but the latter had 70% more water surface. A number of such comparisons were made using different origins and a variety of variables including length of shoreline, length of privately owned shoreline and length of publically owned shoreline. No consistent relationships were discovered.

With no guidelines on which to base the development of the indices and no detailed state summaries of lake characteristics, crude indices were constructed in the following manner. Each county was arbitarily rated on the basis of twelve characteristics as shown in Figure 1. Areas were taken from the previously cited Michigan Lake Inventory printout. Other phenomena were deduced by inspection of Department of Conservation county maps. The scores received for each of the twelve categories were added and the total divided by 100 in order to reduce the values to a range between zero and two since the RECSYS program is constructed in such a manner that the attraction indices should be within this range.[1] The attraction indices thus developed were used in the initial run of the model (see Appendix VII).[2]

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[1]Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., pp. 38-39.

[2]Also shown in Appendix VII are the capacity values, the development of which was described earlier in this Chapter. It was decided to use the actual estimated annual carrying capacity in boat use-periods rather than convert these values into an index because it was felt that this was more realistic and understandable. Also, it would be easier to change the capacity if necessary in subsequent runs.

Attraction Index Calculation Form

Destination: ______________________ Code No: __________

Phenomena	Scoring Schedule	Max. Score	Score

Attraction Index Calculation Form

Destination: ______________ Code No: ________

	Phenomena	Scoring Schedule	Max. Score	Score
1.	Average Size of Lakes	Small - under 25 acres = 0 Medium - 25 to 99 acres = 10 Large - 100 to 499 acres = 20 V. large - over 500 acres = 30	30	
2.	Bonus for Very Large Lakes	For each lake over 2,500 acres (Class 12 and over) score 5	25	
3.	Percent of Lakes with good Road Access	25% = 10 : 50% = 20 75% = 25 : 100% = 30	30	
4.	Percent of Lakes with Public Access Sites	25% = 5 : 50% = 7 75% = 10	10	
5.	Major Town or City on Shore of Great Lakes or Very Good Lake	One = 5; Two or Three = 10 Three or Four = 15	15	
6.	Shoreline Giving Access to Great Lakes	Score 10 if county has Great Lakes shoreline	10	
7.	Great Lakes Harbor	Score 10 for each harbor	10	
8.	Major River Through County	Score 10 for each major river	20	

Figure 1—Continued

	Phenomena	Scoring Schedule	Max. Score	Score
9.	State Park on Great Lakes or Major River	Score 5 for each park	20	
10.	Fishing	Generally good = 10 very good = 20 excellent = 30	30	
11.	Special Scenic Attraction	Excellent = 5 superb = 10	10	
12.	General Pollution of Waters	Mild = minus 10 serious = minus 20 V. bad = minus 30	-30	
		TOTAL	—	

Figure 1. Form Used to Calculate the Initial Crude Boating Attraction Indices for Each Destination

CHAPTER III

THE 1965 SIMULATION

Once the demand data had been compiled, the supply information tabulated and some preliminary attraction and capacity indices computed, it was possible to insert these data in the RECSYS model and run it for boating in 1965. However, the predictions of boating use at the various destinations obtained in this first run were far from being approximately equal to the actual use values developed from the Waterways Division survey. This was to be expected since the various elements of the systems model had not yet been balanced and the attraction indices assigned to each destination were obtained by an intuitive approach.

The next step therefore was to adjust the balance of the model components so that it would predict values that were numerically closer to the observed values. This procedure is known as model calibration and is carried out by adjustment of the scaling constants that control the interelationships of the four main model parameters, namely, highway link resistance, highway link cost, highway trip distance, and destination attraction.[1]

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[1]Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., p. 32.

Initial Calibration Runs of the Systems Model

The first complete run of the RECSYS program for boating utilized the Origin Loading Deck data given in Appendix IV, the Base Utilization Deck data shown in Appendix V, and the Destination Attraction and Capacity Deck information as set out in the 1965 columns of Appendix VIII. The other decks making up the RECSYS program were left substantially the same as in the test program designed by Ellis.[1] No changes were made in the Highway Link Deck since inquiries revealed that there had been only minor alterations in the highway links involved between 1964, the year for which the deck had been designed, and 1965 which was the year being simulated. The RECSYS Program Deck which performs the reading in of the data, the construction of the model, and the printing out of the results, and the small deck which provides the information on how all the other component data are interconnected, were not changed except for some minor alterations due to changes in computer language. The control cards remained the same except for Data Control Card No. 1 which was changed in order to show the correct identification for the run and to give the correct destination attraction scaling.[2]

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[1] *Ibid.*, p. 15.

[2] *Ibid.*, pp. 18-19 and p. 40.

For this initial run, the destination attraction scaling constant was set at 1.6539, this being the average capacity figure for the 72 destination areas[1] multiplied by the suggested initial scaling constant of 0.001.[2] This simulation resulted in a standard deviation of prediction of 352.5 indicating that the model was far from being accurately calibrated.[3] Most of the largely rural destination areas in the upper part of southern Michigan and in the Upper Peninsula were under predicted compared to the known use values given in the Base Utilization Deck. Heavy over prediction occurred in many of the urban areas and counties adjacent to them (see Appendix X). There were some exceptions to this general pattern of under prediction at the resource rich destinations and over prediction at resource poor urbanized destinations, but it appeared that these were due to problems with the magnitude of individual attraction indices.

Since so many of the prime boating destinations were being under predicted on the first simulation, it was clear that the attractive pull of these destinations was being inadequately represented in proportion to the resistance of the highway links. Therefore, the value of the destination

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[1] See Appendix VIII.

[2] Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., p. 40.

[3] Ibid., p. 31.

attraction scaling constant was reduced by a factor of 10 to .16539 on a trial basis. This resulted in a reduction in the standard deviation of prediction to 211.1. The pattern of under prediction at the northern destinations remained, but was not as pronounced so a third calibration run was performed with the destination attraction scaling constant reduced again by a factor of 10 to .016539. This reduced the standard deviation of prediction to 95.0, many of the previously extreme values were closer to the mean deviation and the under prediction in the northern areas was weaker (see Appendix X).

From the rate at which the standard deviation of prediction had been declining it appeared that a further reduction of the destination attraction scaling index by a factor of 10 would probably start to increase the standard deviation of prediction due to exaggeration of the effect of the destination's attraction. Two runs were therefore submitted.[1] In one the constant was reduced by a factor of eight to .002066, which in the other, the factor was reduced by a factor of ten to .001654. The former, called "Run 4A" had a standard deviation of prediction of 80.2 and the latter a value of 81.2.

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[1]Whenever more than one RECSYS model run was submitted at one time each was given the same number and an alphabetically designation added to distinquish between them. This made it possible to easily identify the various stages in calibration.

There was some general improvement in the prediction of the northern areas and the extreme values were further reduced (see Appendix X).

From the pattern of the standard deviation of prediction obtained, it appeared that the .002066 value was close to being the required scaling constant since there was such a small change in the deviation between Run 4A and Run 4B. It was, therefore, decided to attempt to complete the coarse calibration stage by setting the destination attraction scaling constant at .006616 which was approximately midway between the lowest deviation value and the next lowest. This fifth run had a standard deviation of prediction of 82.9 which showed that the constant which would produce the lowest deviation must lie between .00616 and .002066.

Two final simulations were then carried out. Run 6A had a destination attraction scaling constant of .001323 and was intended to prove conclusively that there was no error in Run 4B and the deviation did indeed get bigger as the scaling constant was further reduced. The resultant deviation value of 82.7 proved this point. Run 6B was given a scaling constant of .003308 and resulted in a standard deviation of prediction of 79.9. From this it was concluded that the model would not give a standard deviation of prediction that would be more than a few tenths of one percent

Table 2. Standard Deviations of Prediction Obtained During Coarse and Fine Calibration of the Systems Model[1]

Run No.	Model Calibration Constants: Dest. Attract. Scaling	Model Calibration Constants: Highway Link Rest. Scaling	Model Calibration Constants: Highway Link Cost Weighting	Model Calibration Constants: Highway Link Time-Cost	Resultant Std. Deviation of Prediction
Coarse Calibration					
1	1.653900	1.0000	0.0000	1.5000	352.5
2	0.165390	1.0000	0.0000	1.5000	211.1
3	0.016539	1.0000	0.0000	1.5000	95.0
5	0.006616	1.0000	0.0000	1.5000	82.9
6B	0.003308	1.0000	0.0000	1.5000	79.9
4A	0.002066	1.0000	0.0000	1.5000	80.2
4B	0.001654	1.0000	0.0000	1.5000	81.2
6A	0.001323	1.0000	0.0000	1.5000	82.7
Fine Calibration					
7A	0.003308	1.0000	0.0000	1.1000	86.2
6B	0.003308	1.0000	0.0000	1.5000	79.9
7B	0.003308	1.000	0.0000	1.9000	75.2
7C	0.003308	1.0000	0.0000	2.0000	74.3
8B	0.003308	1.0000	1.0000	2.5000	75.3
8A	0.003308	1.0000	0.5000	2.5000	69.0

[1]Arranged in order of improvement in Standard Deviation of Prediction.

lower than this value with the data being used. The "coarse calibration" stage was thus concluded. The various steps in this procedure are shown in Table 2.

Fine Calibration of the Systems Model

The next step was to carry out fine calibration of the systems model by trying different values for the time - cost exponent and the highway link cost - weighting constant. Leaving the destination attraction scaling constant at the .003308 value identified in the coarse calibration phase, three runs were made simultaneously with the highway link time - cost constant set at 0.00, 0.50 and 1.00 respectively.[1] The standard deviations of prediction of these runs were compared with Run 6B. As will be seen from Table 2, the lowest value was 74.3 obtained for Run 7C with the highway link time - cost constant set at 2.00. However, since it appeared that there had been a uniform improvement, the highway link time - cost constant was set at 2.5, the greatest value suggested by Ellis. Then two runs were made with the destination attraction scaling at 0.003308, the highway link time - cost constant at 2.5, and the highway link cost - weighting constant set at 0.50 and 1.00 respectively as shown in Table 2.

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[1] *Ibid.*, p. 36

These runs resulted in standard deviations of prediction of 69.0 and 75.3 compared to the 74.3 value obtained in Run 7C. Therefore, the values finally selected for running the model during the next stage of refinement were 0.003308 for the destination attraction scaling constant, 2.5 for the highway link time - cost constant and 0.5 for the highway link cost - weighting constant.

Since Run 8A still had a much larger deviation than the data warranted, the next step was to try to reduce it further by a "fine-tuning" process in which the actual individual attraction indices were modified in order to bring the predicted values closer to the known values.[1] Because some of the deviations of prediction were very large, it was decided to attempt to reduce the effects of these large errors first since they were undoubtedly causing considerable distortion in the flow patterns.

The three biggest deviations were the 266.1 percent value for Monroe County, the 239.9 percent figure for Sanilac County, and the 162.3 percent deviation for Clinton-Gratiot Counties. As a first step, the attraction indices of all the destinations with deviations over 70 percent were raised or lowered in approximate proportion to the size of the deviation. For example, in the case of Monroe, the model was over

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[1] Ibid., p. 41.

predicting boating use by 266.1% when the attraction index was set at 0.80 so the index was reduced to 0.20. Similar changes were made in fourteen other cases where the deviation was 70 percent or more.

The modified attraction indices were incorporated in RECSYS Run No. 9 (see Appendix XI). This run resulted in the standard deviation of prediction dropping to 44.9 and gave the predicted and individual deviations shown in the center columns of that table. It will be observed that the extreme deviations have been eliminated but some of the higher deviations at destinations with large boating participation were not significantly changed by adjustment of their attraction indices. For example, adjustment of the attraction index for Clinton-Gratiot from 0.33 to 0.10 changed the deviation from +162.3 percent to -12.4% while in the case of Bay County the deviation dropped from +133.9 percent to +53.0% when the index was reduced from 0.64 to 0.30. Adjustment of the 15 indices in Run 9 resulted in the largest deviation being the -88.1 percent value for Emmet County. Only six predictions showed deviations in excess of plus or minus 70 percent.

At this point the distribution of the negative and positive deviations and their relative magnitudes were once more considered. A strong tendency had again emerged for most southern destinations near urban centers to be over predicted while destinations in the central and northern part of the state were considerably under predicted. (Exceptions were Eaton-Ingham, Jackson, Kent, and Genesee-Lapeer, where the populations are reasonably large but the run still gave under predictions).

There are three possible reasons for this pattern. First, it could be that the scaling constants were not adjusted perfectly during the calibration phase because the several obviously inaccurate attraction indices distorted the flows so much that further adjustments resulted in proportional greater deviations in these extreme cases and thus gave higher standard deviations of prediction. The second possibility is that there were certain common factors in the overall attractiveness of these central and northerly destinations that had been overlooked. (These factors could be such influences as climatic advantages, the social desirability of owning summer cottages in these areas, and the availability and prices of land suitable for cottage or resort development). The third conceivable reason is that the pattern is due to a combination of both these factors.

Careful inspection of the pattern led to the conclusion that at least part of the problem was due to attraction index inaccuracies so changes were made in nearly all indices in proportion to the percent deviations recorded in Run 9. When these values were substituted and used in Run 10, the standard deviati

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ard deviation of prediction dropped to 36.8 and several of the extreme deviations were eliminated. The preponderance of positive deviations in the southern urbanized portion and negative deviations at the northern destinations was still strongly evident indicating the necessity of further revision of the destination attraction scaling constant.

As a first step, Run 11 was submitted with this constant decreased by the power of 10 to .000331 while the other constants and the individual attraction indices remained at the values used in the previous run. The standard deviation of prediction rose to 67.3, some of the northern destinations became over predicted and the southern destinations which had previously been over predicted now had substantial negative deviations. For example, Wayne County dropped from +36.4 to -22.7. Clearly the change in the destination attraction constant had been too great so Run 12 was made with the constant set at .001819. This resulted in the standard deviation of prediction dropping to 37.8 but the southern destinations were being over predicted once more.

Therefore, two simultaneous runs were made with destination scaling constants set between the values used for Runs 11 and 12. Run 13A with a constant of .000993 had a standard deviation of 44.3 while Run 13B using .001324 as the destination attraction scaling constant had a deviation of 40.5. However, Run 13A had lower individual deviations for the southern populated destination areas. The deviation for Wayne County was +10.0, for Oakland +0.4 and for Macomb -17.9. There was still a considerable number of northern destinations that were under predicted but most of the destinations with high boating use were within 10 or 20 percent of the correct prediction. It was therefore assumed that in Run 13A the model was in reasonable overall balance again and a destination attraction scaling index of .000993 was selected for use in the runs that followed.

For Run 14, the individual attraction indices were again modified in proportion to their percent deviations in Run 13A. This resulted in a standard deviation of 27.3 with half the predictions being within plus or minus 10 percent of the observed values. The predictions for the southern areas were particularly close with few showing substantial deviation. A group of northern destinations again contributed a substantial negative deviation but it was decided to make a further complete revision of the individual attraction indices before attempting to correct this situation.

This was done in Run 15, all the indices being raised or lowered in proportion to the individual deviations experienced in Run 14. The result was a standard deviation of prediction of 24.8 and a significant reduction in the error in the case of a number of the more southerly destinations that had sizeable deviations. The northerly destinations that were considerably over predicted generally showed little improvement. In some cases the deviations actually increased.

The next step in the fine-tuning procedure was to attempt to produce a further reduction in the under prediction of the northern areas but at the same time, preserve or improve the level of accuracy in the southern sections. As a first attempt, Runs 16A and 16B were submitted with the destination scaling constant set at .000827 and .000662 respectively. The resultant standard deviations of prediction were 25.5 and 28.0. Run 16A with the lower value appeared to be best since there was some improvement in the northern sections but the southern destinations with large boating usage were generally still being reasonably accurately predicted.

Next, a change was made in the highway link time - cost exponent in order to reduce the penalty imposed for long trips. It was decreased from 2.5 to 2.0 and this reduced the standard deviation of prediction to 24.8. A further reduction in this exponent did not appear to be advisable since the deviation in the case of some of the heavily used southern destinations started to rise and only slight improvement in a few of the extreme values at more northerly destinations was observed.

Finally, the individual attraction indices were once again revised in proportion to the percent error of each prediction and the modified program submitted as Run 18. The resultant standard deviation of prediction was 19.2 with thirty-one of the predictions falling within plus or minus five percent and another twenty lying between five and ten percent as shown in Table 3. Some extreme values persisted. The largest was the -82.6 percent error in the case of Emmet County. This destination was severely under predicted throughout the calibration and fine-tuning phases, remaining remarkably close to the above value even when adjacent counties were influenced considerably by changes in the indices. The next largest errors in prediction were experienced with Luce County where the error was -71.0 percent and Chippewa where the value was -51.4 percent. Like Emmet, the predictions for these destinations showed little inclination to change greatly throughout the calibration and tuning procedures.

Since the tuning process had occupied two months and involved some twenty-five computer runs of the RECSYS program, it was decided that further tuning of the model was not feasible at that time and the values obtained in Run 18 were adopted for use in the subsequent simulation phase.[1] However, the 19.2 percent standard deviation obtained appeared to be reasonable in view of the 19.8 percent standard deviation

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[1] The author was limited in the number of runs that could be made at each stage in calibration and tuning since time constraints made it necessary to pay for each run in order to obtain priority at the computer, and each one costs approximately $25.

Table 3. Results of the Final Run (No. 18) in the Model Calibration and Tuning Procedure

No.	Destination[a]	Prediction[b]	Error[c]	Percent Error[d]
901	Baraga	32,447	-1,673	-4.9
902	Gogebic	66,264	-14,036	-17.5
903	Houghton	83,208	-8,052	-8.8
904	Keweenaw	3,743	-347	-8.5
905	Ontonagon	19,510	-920	-4.5
906	Dickinson	37,023	-18,837	-33.7
907	Iron	60,227	-8,513	-12.4
908	Menominee	33,015	-5,645	-14.6
909	Alger	27,720	-1,750	-5.9
910	Delta	42,395	-12,165	-22.3
911	Marquette	76,072	-1,388	-1.8
912	Chippewa	71,077	-75,033	-51.4
913	Luce	11,984	-29,296	-71.0
914	Mackinac	169,731	-25,239	-12.9
915	Schoolcraft	51,235	-26,055	-33.7
916	Alpena	105,859	-1,211	-1.1
917	Antrim	114,612	-78,068	-40.5
918	Charlevoix	84,133	-35,867	-29.9
919	Cheboygan	218,611	-98,169	-31.0
920	Emmet	22,685	-108,005	-82.6
921	Montmorency	76,994	-15,326	-16.6
922	Otsego	90,748	-28,172	-23.7
923	Presque Isle	77,107	-28,363	-26.9
924	Benzie	115,398	4,218	3.8
925	Grand Rapids	324,599	14,589	4.7
926	Leelanau	180,363	38,863	27.5
927	Lake	118,266	14,206	13.7
928	Mason	123,861	9,301	8.1
929	Manistee	102,470	14,740	16.8
930	Newaygo	359,881	25,401	7.6
931	Oceana	98,997	6,867	7.5
932	Wexford	119,402	11,092	10.2
933	Alcona	147,567	11,277	8.3
934	Crawford	32,009	1,049	3.4
935	Iosco	351,808	15,898	4.7

Table 3--Continued

No.	Destination[a]	Prediction[b]	Error[c]	Percent Error[d]
936	Kalkaska-Miss.	168,193	5,503	3.4
937	Og.-Oscoda	188,167	-58,943	-23.9
938	Roscommon	451,474	25,354	6.0
939	Arenac	65,959	3,839	6.2
940	Bay	173,103	5,263	3.1
941	Clare-Gladwin	380,847	22,577	6.3
942	Isabella	35,588	1,938	5.8
943	Midland	54,393	2,343	4.5
944	Mec.-Osceola	264,556	17,046	6.9
945	Kent	307,589	12,379	4.2
946	Ionia-Mont.	308,478	12,558	4.2
947	Muskegon	236,322	10,712	4.7
948	Ottawa	377,584	19,754	5.5
949	Clinton-Gratiot	21,890	160	0.7
950	Eaton-Ingham	60,077	2,577	4.5
951	Livingston	462,767	12,337	2.7
952	Saginaw	23,649	-961	-3.9
953	Shiawassee	9,303	323	3.6
954	Gen.-Lapeer	484,034	19,534	4.2
955	Huron	221,068	22,988	11.6
956	St. Clair	745,196	46,796	6.7
957	Sanilac	33,502	-3,038	-8.3
958	Tuscola	82,594	-706	-0.8
959	Allegan	202,712	10,892	5.7
960	Barry	511,513	25,943	5.3
961	Berrien	193,819	3,509	1.8
962	Cass-St. Joseph	662,713	33,733	5.4
963	Kalamazoo	283,135	12,975	4.8
964	Van Buren	271,999	14,119	5.5
965	Branch-Calhoun	503,744	30,284	6.4

Table 3--Continued

No.	Destination[a]	Prediction[b]	Error[c]	Percent Error[d]
966	Hillsdale-Len.	385,320	17,450	4.7
967	Jackson	416,537	14,727	3.7
968	Monroe	186,204	-8,236	-4.2
969	Washtenaw	335,098	9,718	3.0
970	Macomb	838,098	33,208	4.1
971	Oakland	1,020.097	33,397	3.4
972	Wayne	973,999	42,529	4.6

[a]In this and all subsequent tables, the destination counties are arranged in order of their location in Department of Conservation administrative districts in order to facilitate totalling by district or region.

[b]Is the actual prediction of the RECSYS model in boat use-periods.

[c]Is the difference between the prediction and the known boat use-periods value for the destination concerned (see Appendix III).

[d]Is the error expressed as a percentage of the known value.

of prediction obtained by Ellis with his systems model for state park camping, which had fewer components, was provided with better attraction index information and employed more reliable use data by origin and destination. A comparison of the values obtained in Table 3 and the results of the Ellis simulation[1] indicates that Run 18 of RECSYS is a considerably closer "fit" to the observed values than the "fit" obtained in state park camping simulation although the standard deviations of prediction are almost identical.

Simulation and Mapping of 1965 Supply, Demand, and Surplus

Once the calibration and fine tuning procedures were completed, it was possible to make a RECSYS simulation run for 1965 which included allowances for boating in unregistered boats and out-of-state boats. The origin loading deck was modified by the addition of assumed values for boating by out-of-state boaters and for boating undertaken in unregistered boats by means of the techniques described earlier. The four scaling constants and the attraction indices were those used in Run 18. Following the running of the RECSYS program using these values, the resultant demand predictions were corrected

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[1]Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, op.cit., pp. 6-10, 6-11.

individually according to the under prediction or over prediction observed in Run 18. The values for 1965 total boating demand thus obtained are shown in column "a" of Table 4. Each individual demand estimate was then subtracted from the total estimated supply of boating opportunities for the destination concerned as calculated earlier (see Appendix VII). The remainder is the "surplus" of boating opportunities shown in column "c" of Table 4.

The values thus obtained for 1965 total boating demand, supply, and surplus were then punched on data processing cards to form three separate SYMAP data decks.[1] An initial test run of the SYMAP program was made using the 1965 supply data deck and calling for percentage decile scaling--that is, for each of the ten levels of shading on the maps to cover an equal range of boat use-periods equivalent to one-tenth of the total range of the data. It was hoped that this simple scaling would give maps that illustrated the distribution of demand, supply, and surplus fairly clearly because the direct arithmetic relationship involved would be relatively easy to comprehend. However, it was found that the percentage decile scal-

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[1]Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part II, op.cit., pp. 6-8.

Table 4. Results of 1965 Simulation in Terms of Demand, Supply, and Surplus

Code No.	Destination	Boat Use-Periods		
		Demand[a]	Supply[b]	Surplus[c]
901	Baraga	42,387	2,078,000	2,035,613
902	Gogebic	116,828	3,225,900	3,109,072
903	Houghton	107,356	2,542,400	2,435,044
904	Keweenaw	4,679	2,137,500	2,132,821
905	Ontonagon	28,063	1,674,300	1,646,237
906	Dickinson	80,557	453,600	373,043
907	Iron	93,483	1,771,200	1,677,717
908	Menominee	121,289	1,365,400	1,244,111
909	Alger	48,285	3,302,400	3,254,115
910	Delta	104,624	3,521,800	3,417,176
911	Marquette	121,135	4,144,900	4,023,765
912	Chippewa	121,202	8,065,700	7,944,498
913	Luce	23,810	1,667,600	1,643,790
914	Mackinac	211,488	5,773,700	5,562,212
915	Schoolcraft	88,567	3,210,200	3,121,633
916	Alpena	120,201	2,974,600	2,854,399
917	Antrim	181,487	2,776,300	2,594,813
918	Charlevoix	122,201	5,257,800	5,135,599
919	Cheboygan	317,469	5,366,900	5,049,431
920	Emmet	45,718	1,629,800	1,584,082
921	Montmorency	102,543	828,000	725,457
922	Otsego	129,004	482,400	353,396
923	Presque Isle	188,252	1,008,000	819,748
924	Benzie	131,447	2,064,900	1,933,453
925	Grand Traverse	354,982	2,039,800	1,684,818
926	Leelanau	151,576	3,653,500	3,501,924
927	Lake	124,319	309,600	185,281
928	Mason	138,989	1,472,900	1,333,911
929	Manistee	102,497	1,295,000	1,192,503
930	Newaygo	413,233	828,000	414,767
931	Oceana	113,140	1,025,200	912,060
932	Wexford	127,213	468,000	340,787
933	Alcona	156,497	1,679,900	1,523,403
934	Crawford	36,259	180,000	143,741
935	Iosco	392,028	1,713,800	1,321,772

Table 4—Continued

Code No.	Destination	Boat Use-Periods Demand[a]	Supply[b]	Surplus[c]
936	Kalkaska-Missaukee	190,047	892,000	701,953
937	Ogemaw-Oscoda	273,497	833,600	560,103
938	Roscommon	498,853	2,815,200	2,316,347
939	Arenac	72,952	1,010,800	937,848
940	Bay	198,491	1,842,200	1,643,709
941	Clare-Gladwin	423,615	871,200	447,585
942	Isabella	40,040	79,200	39,160
943	Midland	61,502	180,000	118,498
944	Mecosta-Osceola	298,106	799,200	501,084
945	Kent	369,061	576,000	206,939
946	Ionia-Montcalm	360,616	648,000	287,384
947	Muskegon	284,053	1,559,400	1,275,347
948	Ottawa	459,310	1,094,700	635,390
949	Clinton-Gratiot	26,454	158,400	131,946
950	Eaton-Ingham	70,887	108,000	37,113
951	Livingston	556,155	662,400	106,245
952	Saginaw	29,417	100,800	71,383
953	Shiawassee	10,878	64,800	53,922
954	Genesee-Lapeer	555,895	698,400	142,505
955	Huron	233,006	2,942,600	2,709,594
956	St. Clair	842,124	2,476,100	1,633,976
957	Sanilac	43,562	1,093,200	1,049,638
958	Tuscola	99,317	637,200	537,883
959	Allegan	260,839	1,289,100	1,028,261
960	Barry	623,808	748,800	124,992
961	Berrien	312,218	1,441,100	1,128,882
962	Cass-St. Joseph	842,860	1,339,200	496,340
963	Kalamazoo	353,068	698,400	345,332
964	Van Buren	385,294	821,300	436,006
965	Branch-Calhoun	609,732	921,600	311,868
966	Hillsdale-Lenawee	466,392	686,800	220,408
967	Jackson	503,366	705,600	202,234
968	Monroe	291,208	1,090,500	799,292
969	Washtenaw	408,568	640,800	232,232
970	Macomb	976,888	1,085,400	108,512

Table 4—Continued

Code No.	Destination	Boat Use-Periods		
		Demand[a]	Supply[b]	Surplus[c]
971	Oakland	1,182,633	1,656,000	473,367
972	Wayne	1,159,376	1,825,400	666,024
	TOTALS	19,136,896	119,082,400	99,945,494

[a]"Demand" is the value obtained from RECSYS simulation corrected in accordance with percent errors obtained in final tuning run.

[b]"Supply" is the 1965 capacity value - see Appendix VII.

[c]"Surplus" is the amount by which "Supply" exceeds "Demand."

ing did not give a good indication of the considerable variation in the capacities of the many destinations at the lower end of the range. This was because the majority of the values were at the lower end of the scale so two or three levels of shading were being required to represent a large number of values. The program was, therefore, altered to call for the left-hand logarithmic scaling[1] which had levels set at 0.0 to 2.5, 2.6 to 6.0, 6.1 to 14.9, 15.0 to 36.5, 36.6 to 89.8, 89.9 to 220.8, 220.9 to 542.9, 543.0 to 1,335.2, 1,335.3 to 3,281.6, and 3,281.7 to 8,067.7. The SYMAP test run of 1965 supply was repeated with this scaling and produced a map with a satisfactory range of shading (see Figure 5).

It was decided to use left-hand expanded logarithmic scaling for all the SYMAP runs. This was done with the knowledge that it would result in the range of value levels being less than optimal in the case of phenomena that had few comparatively low values. However, the selection of a single type of scaling and the same range of values for all of the SYMAP runs would make direct comparison of the various maps possible.

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[1] A left-hand logarithmic scaling means that there are more levels in the low values - that is, the class intervals are smaller for the low end of the scale. This type of scaling is useful when data consisting of many low values and few high values is being mapped.

Regionalization of Demand, Supply, and Surplus

The halves of the SYMAP print-outs of both a choropleth map and an isopleth map for 1965 demand, supply, and surplus were then joined, mounted and reduced photographically to produce the illustrations of SYMAP used in this Chapter.[1] Each set of maps will be discussed separately from the viewpoint of the regions revealed.

1965 Boating Demand

The isopleth map of 1965 boating demand, Figure 2, shows a region of high demand in the Detroit metropolitan area consisting of Wayne, Oakland, Macomb, and St. Clair Counties. Barry County is the only other area that stands out at this high level. The rest of the Lower Peninsula is shown to have medium - high demand with the exception of the core area consisting of Clinton, Shiawassee, and Gratiot Counties, and to some extent also Eaton, Ingham, Saginaw,

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[1]All the SYMAP print-outs reproduced in this thesis have a north - south scale which is exaggerated by one-third compared to the east - west scale. This is because the SYMAP program used was written for a computer printer with 8 lines to the inch spacing since this gives a better quality map. Unfortunately, it was not possible to arrange to print the maps on the new printer of this type which had just been installed by the School of Urban Planning and Landscape Architecture. Note also that the Upper Peninsula is displaced to right in order to permit the map to be at a larger scale on a double width of printer paper than would otherwise be possible.

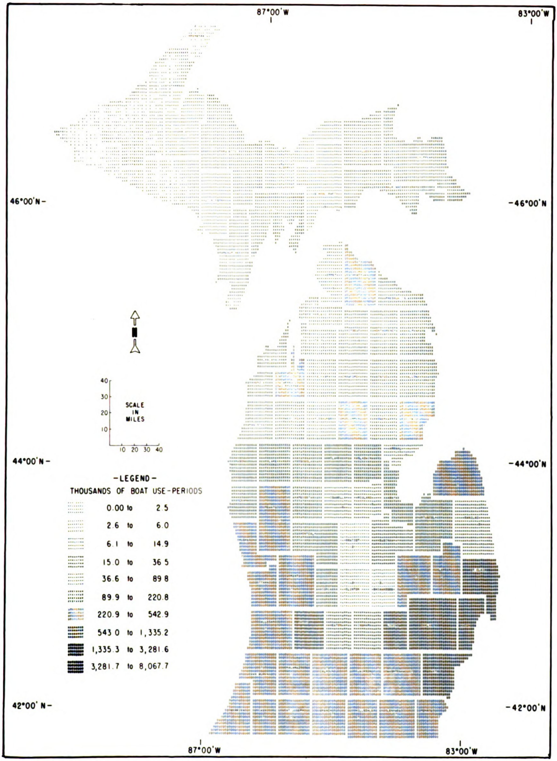

Figure 2. Isopleth Map of 1965 Boating Demand at Michigan Destination Counties

Isabella, and Midland Counties. The Upper Peninsula is shown as a region of generally medium to low boating demand with no strong differentiation into separate zones.

The choropleth map shown in Figure 3 indicates the distribution of 1965 boating demand even more dramatically. The high demand region in southeastern Michigan is shown to be oriented towards the St. Clair River, Lake St. Clair and the Detroit River which is a more realistic representation of the actual situation. The low use region in the center of the Lower Peninsula is also better represented. Small, county sized patches of lower demand within the generally medium to high demand of the Lower Peninsula occur in the Sanilac-Tuscola area, in the Crawford-Kalkaska region, and also in Emmet County. In the Upper Peninsula, the generally medium to low boating use pattern is modified to some extent by the higher demand regions in Chippewa and Mackinac Counties and the low use region in Keweenaw County. The five boating demand regions that were developed from this analysis are listed in Table 5 and shown graphically on Map A in Figure 8.

1965 Boating Supply

In Figure 4 and 5, boating supply is shown to have a distributional pattern that is considerably different from the pattern exhibited by 1965 boating demand. The strong influence of the boating opportunities offered by the Great

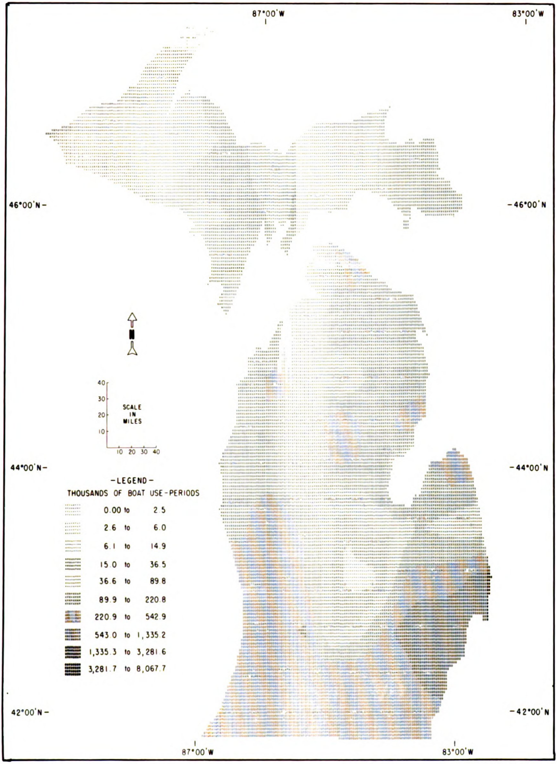

Figure 3. Choropleth Map of 1965 Boating Demand at Michigan Destination Counties

Table 5. List of Boating Destination Demand Regions for 1965

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Demand	Over 543.0	Wayne, Oakland, Livingston Macomb, and St. Clair Counties
II	Medium - High Demand	89.9 to 542.9	Major part of the Lower Peninsula plus the eastern and southwestern parts of the Upper Peninsula
III	Medium Demand	15.0 to 89.8	Central and northwest parts of the Upper Peninsula and Emmet County
IV	Medium - Low Demand	6.1 to 89.8	The central area of the Lower Peninsula around Clinton and Gratiot Counties
V	Low Demand	Below 14.9	Keweenaw Peninsula

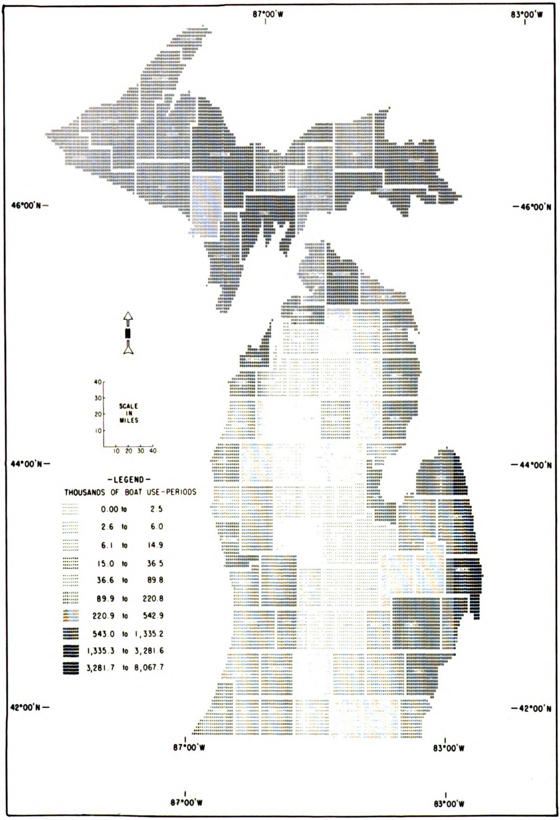

Figure 4. Isopleth Map of 1965 Boating Supply by Michigan Destination Counties

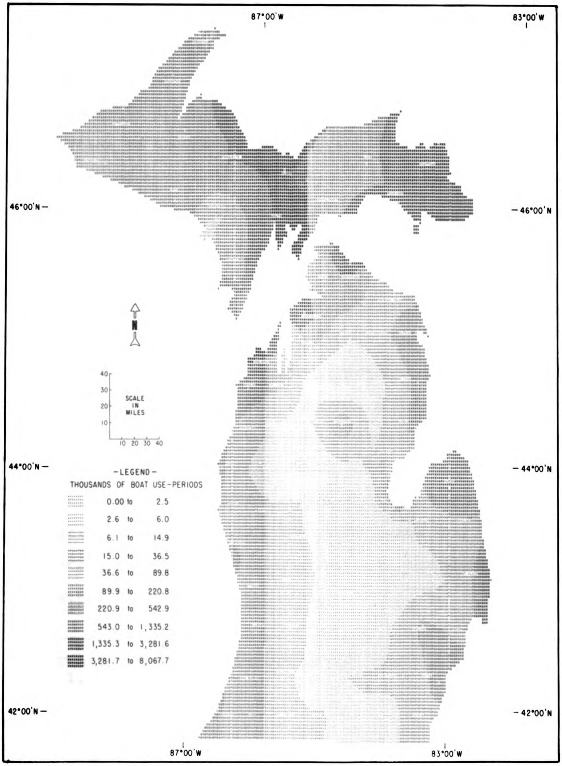

Figure 5. Choropleth Map of 1965 Boating Supply by Michigan Destination Counties

Lakes is apparent in the isopleth map but the patterns become even clearer in the choropleth version. The regions developed are listed in Table 6 and shown graphically on Map B in Figure 8.

It must be pointed out that there is a certain amount of distortion in the pattern due to the fact that the boating supply provided by the Great Lakes acts through the destination node for that particular county. In some cases the node is central to the county and, therefore, is situated some distance from the shoreline so the zone of high supply tends to extend inland rather than be concentrated along the shore. In other cases, the destination nodes of shoreline counties are located on the coastline and distortion is less evident.[1] However, it must be remembered that all the boating capacity and demand attributed to Great Lakes waters (see Appendix VII) does actually occur outside the land area of the county. The distribution of this element in boating supply and to some extent boating demand, surplus, and needs means that the SYMAP print-outs are diagramatic representations for planning purposes rather than precise indications of spatial dispersion.

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[1]The location of the destination nodes is discussed in Chapter I.

Table 6. List of Boating Supply Regions in 1965

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Supply	Over 1,335.3	Most of the Upper Peninsula plus six areas along the coastline of Lower Michigan
II	Medium - High Supply	543.0 to 1,335.2	A belt one or two counties wide around the Lower Peninsula plus an area centered in Roscommon County
III	Medium Supply	89.9 to 542.9	An elongated central area in the Lower Peninsula from the state line in the south to Otsego County in the north
IV	Medium - Low Supply	36.6 to 89.8	A small zone within the southern portion of the elongated central area. Clinton, Shiawassee, Eaton and Ingham are the principal counties involved

<u>1965 Boating Supply Surplus</u>

The distribution of the 1965 boating supply surplus is shown in SYMAP form in Figures 6 and 7. The regions are described in Table 7 and shown graphically in Figure 8.

From inspection of Figure 7 and comparisons of the maps in Figure 8, it will be seen that in 1965 Michigan had some fair sized areas of high boating supply surplus but that these were concentrated in the Upper Peninsula, the northern part of the Lower Peninsula and in the "thumb." These areas, constituting Region I, were linked by zones of medium - high surplus (Region II) along the Lake Michigan, Lake Huron, and Lake Erie shoreline sections of Lower Michigan. There were no actual deficit areas but the central core counties around Clinton County had relatively low supply surplus values. This part of Michigan has relatively few lakes and is known to be a region where more boating opportunities are needed. However, since demand in this analysis has been based on where people actually go to boat, the absence of a major deficit is understandable.

It should also be remembered that an attempt has been made to relate supply to demand in terms of the total annual supply and demand. The problem of adequate supply during peak periods has already been mentioned. It appears that under our present patterns of use, a need for additional

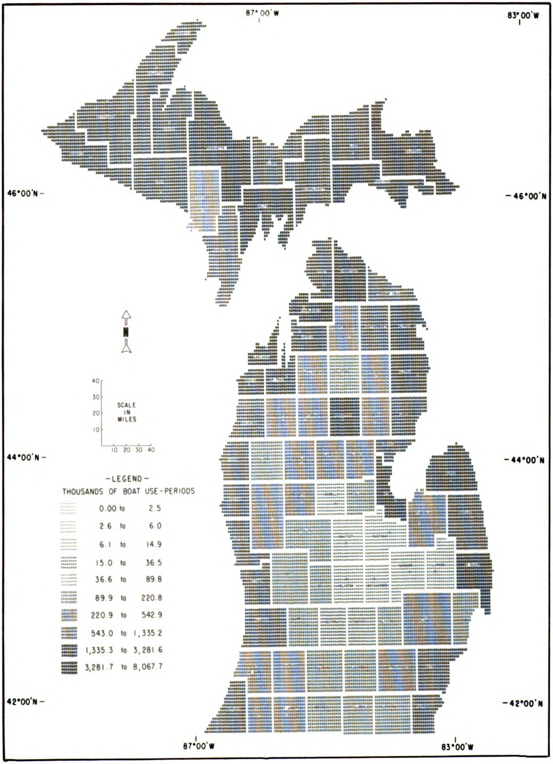

Figure 6. Isopleth Map of 1965 Boating Supply Surplus by Michigan Destination Counties

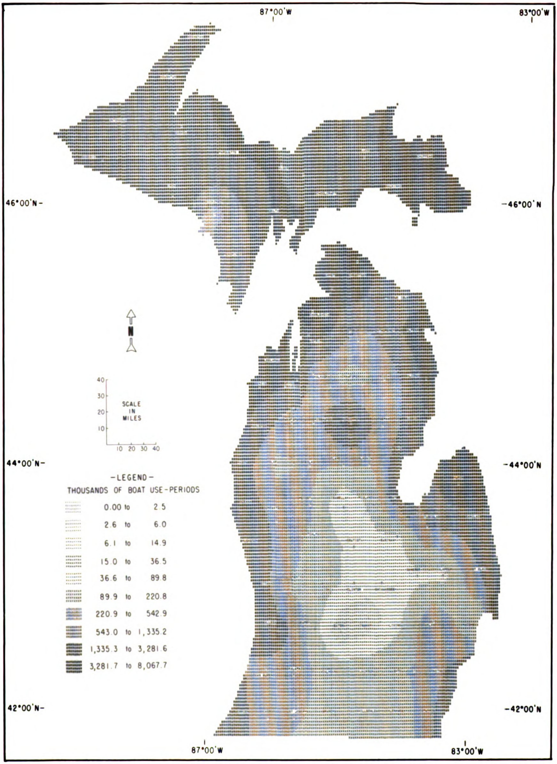

Figure 7. Choropleth Map of 1965 Boating Supply Surplus by Michigan Destination Counties

Table 7. List of Boating Supply Surplus Regions in 1965

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Surplus	1,335.3 to 8,067.7	Most of the Upper Peninsula plus four areas along the coast of Lower Michigan
II	Medium - High Surplus	543.0 to 1,335.3	A fairly narrow belt less than one county wide around the Lower Peninsula plus an area centered on Roscommon County
III	Medium Surplus	89.9 to 542.9	The major portion of the internal part of Lower Michigan except for the central area
IV	Medium - Low Surplus	15.0 to 89.8	An area centered about Clinton County

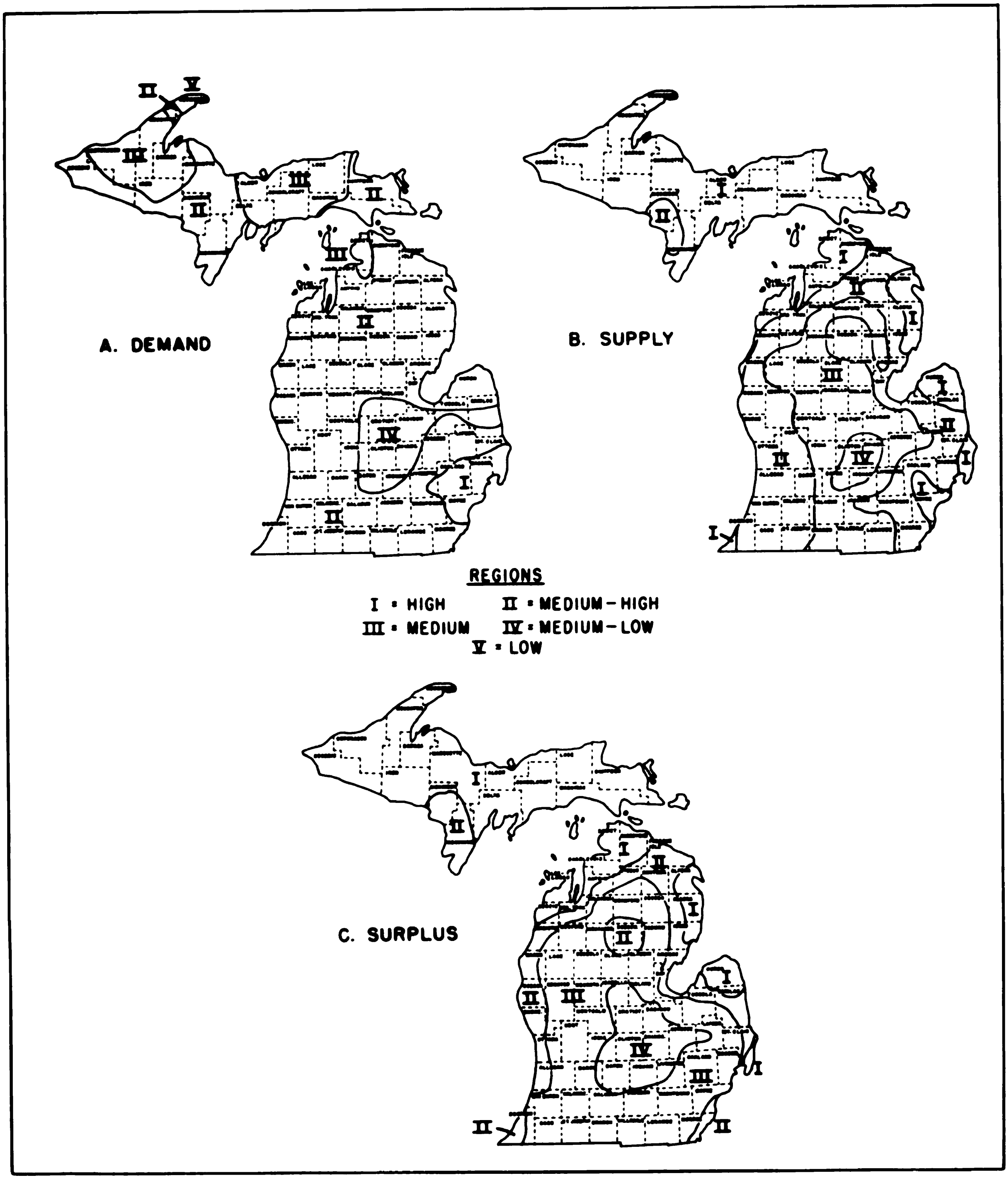

Figure 8. Generalized Maps of Boating Demand, Supply, and Surplus and Regions in 1965

boating opportunities probably exists wherever the surplus drops below about 200,000 boat use-periods per year. Further discussion of the planning and management implications of this analysis is beyond the scope of this thesis.

Running the complete RECSYS-SYMAP program for 1965 boating accomplished three things. It enabled the model to be calibrated with actual use data, it made it possible to check out the overall performance of the RECSYS-SYMAP technique under known conditions, and it provided base year information which could be compared to corresponding data obtained by simulation of probable situations in future years. The next step was to run the RECSYS-SYMAP process for boating in 1980, the target planning year.

CHAPTER IV

THE 1980 SIMULATION

In order to make the proposed test of the RECSYS-SYMAP program for boating in 1980 it was necessary to gather information on the probable nature and extent of the cultural changes which could affect recreation participation by that time. This new information was then substituted in the calibrated and tuned 1965 RECSYS program in order to simulate 1980 conditions. In a few cases, the information on probable future conditions was readily available. In several other instances, present inadequate knowledge of recreation behavior makes it difficult to forecast future trends. In these cases it is recognized that the magnitude of the values substituted in the program may be subject to debate. However, it is felt that they are reasonable estimates and that their use is justified since this thesis is primarily concerned with testing the RECSYS-SYMAP technique as applied to Michigan.

Assumed Changes in Highway Linkages

Due to the long range planning and design activities of Michigan Department of State Highways, it was possible to modify the highway linkages in the RECSYS model with reasonable assurance that the revised model would bear a close resemblance to the actual main highway system in 1980. Since it has been reliably predicted that a major change in the type of vehicle used for family transportation[1] is unlikely by 1980, it appears that the transportation aspects of the 1980 RECSYS model are least likely to be seriously in error.

The changes that were made in the 1965 highway link deck to convert it to 1980 were based on maps and information supplied by the Michigan Department of State Highways.[2] Since no radically new highway routes are likely to have been constructed by 1980, it was possible to leave the configuration of the model the same so that the 1980 link deck has the same number of components with basically the same relationships to one another. In a few cases the straightening of routes has made it possible to reduce the distance assigned to a particular link.

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[1]Randolph B. Lutz, <u>The Motor Vehicle of the Future</u> (Lansing, Michigan: State Resource Planning Program, Michigan Department of Commerce, February 1966), Technical Report No. 2, p. 3.

This source states that "The motor vehicle of the future, 1980 and beyond, will continue to roll on pneumatetired wheels," and "Tomorrow's passenger cars will not differ materially from the current models in size and passenger accomodations."

[2]These data were supplied by Mr. W.E. Bailey, Assistant Chief, System Planning Section, Michigan Department of State Highways.

The major changes made were in the speeds assigned. It was assumed that by 1980 average speeds will generally be higher due to better vehicles. Although the vehicle transporting the recreation user may still travel somewhat slower than the average for all passenger vehicles due to added loads, trailers, and use at peak flow periods, it was assumed that these vehicles will generally travel faster than the speeds assigned for the 1965 situation. For example, for 1965 it was assumed that on divided four lane controlled access highways, the recreational vehicle would average 60 m.p.h. For 1980, the speed was raised to 65 m.p.h. Similarly, the speed on three lane arterial highways was raised from 55 to 60 m.p.h., on secondary arterial highways from 50 to 55 m.p.h. and on area service highways from 40 to 45 m.p.h. in some areas where urbanization is unlikely to hold speeds down. The toll of $1.50 assigned to travel on link 634 from Chicago was left at the same value but the Mackinac Bridge toll of $5.00[1] was reduced to $1.00. Recent legislation introduced in both Houses of the Michigan Legislature suggested a fifty cent one-way toll so a $1.00 value was adopted as the probable 1980 average cost to users with recreation equipment. The values for the 1980 highways links are compared to the

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[1]This value had been used previously by Ellis and is assumed to be an average value representative of the various types of vehicles and trips involved.

1965 values in Appendix IX. These 1980 values were used without further modification in all simulations of 1980 conditions.

Assumed Changes In Supply Factors

In order to prepare the RECSYS model for a simulation of 1980 conditions both the attraction index and capacity values for each destination must be carefully checked to see if any significant changes in the factors on which they depend can be expected by that time.

Capacity

The actual total annual carrying capacities of the various destinations in the RECSYS model are unlikely to change appreciably. This is to say, the actual acreage of water available in or adjacent to each county is likely to remain generally constant. There may be some relatively small additions to the boatable acreage available due to the construction of compoundments and ponds but no major developments are contemplated such as have completely altered the patterns of recreation activity in some western states. Even if funds were available, few potential sites exist in southern Michigan where the additional acreage is needed. (Some small impoundments have been proposed and these will be discussed later in this section). The Trans-Michigan Waterway proposed by former Representative John C. Mackie which would cost "less than $1 billion" and involve the movement of Lake Huron water from near Port Huron through a series of pumping stations and reservoirs and across the southern part of the state to Lake Michigan[1] does not appear to be likely to become a reality--certainly not before 1980.

There are some influences which may reduce the area of water available to boating in certain counties. For example, the gradual filling in of lakes by vegetation is reducing available acreage especially in the southern part of the state where agriculture and domestic pollution are accelerating the process. On the other hand, some of the lakes of this type are being improved by dredging. There is no information on the net effect county by county and it will be assumed that the total acreage of boatable water will not be reduced by a significant amount in the next thirteen years. Another possible way in which boatable acreage may decrease is the removal of existing dams. This does not appear to be likely to cause a major drop in acreage since the number of impoundment dams that will reach a condition where repair is inadvisable is comparatively small and the policy has generally been to make sure dams are maintained even if the purpose for which they were built no longer exists. Other factors

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[1] Towne Courier (East Lansing), November 29, 1966.

that impinge on the number of boating opportunities an acre offers such as changes in access and pollution are considered in setting the attraction indices later in this chapter.

In view of the facts explained above, it was decided to use the same annual carrying capacity values for 1980 as were used for 1965 except for the counties where State lakes are to be built, but change the attraction indices in order to represent probable 1980 conditions. The State lakes proposal had only reached the stage of actual site acquisition and development in two cases when the simulation of 1980 boating was carried out. These two sites were Sleepy Hollow State Park in Clinton County where the lake will have some 500 boatable acres, and Ionia State Park where the lake will be about 100 acres in extent.

Apart from these two lakes, the proposed artificial lake system in the "lakeless" counties of southern Michigan had not been planned in detail. The total program had been suggested in several different forms from 100 five acre lakes to ten 500 acre lakes. At the time of 1980 simulation, the opinion of Department of Conservation officials was that the program was likely to produce about 5,000 acres of additional water by 1980 in the form of artificial lakes between 50 and 100 acres in extent lying in the "lakeless" area consisting of Midland, Gratiot, Saginaw, Ionia, Clinton, Shiawassee, Genesee, Eaton, Ingham and Isabella Counties.[1] Taking into account some possible sites suggested by Department officials, the probable distribution of these lakes was assumed to be as shown in Table 8. These values were converted to boat use-periods and added to the boating carrying capacity of the counties concerned.

Table 8. Assumed Distribution of Additional Water Acreage Produced by Department of Conservation Artificial Lakes Program by 1980

County	Acres	Boat Use-Periods
Clinton	500	36,000
Eaton	400	28,800
Genesee	200	14,400
Gratiot	400	28,800
Ingham	300	21,600
Ionia	700	50,400
Isabella	600	43,200
Midland	800	57,600
Saginaw	500	36,000
Shiawassee	600	43,200
TOTALS	5,000	360,000

[1] *Supra.*, p. 20.

This resulted in comparatively small changes in the total amount of boating opportunities available. In fact, it was later found that the changes were not large enough to make the 1980 SYMAP of boating supply significantly different from the 1965 map so a 1980 supply map has not been reproduced in this study.

Attraction

As explained earlier, the performance of the RECSYS model in the 1965 simulation indicates that the attraction of an area for boating is more closely correlated with the degree of development of summer and permanent residential areas and the ease of access to the water for boaters than it is with the magnitude of the natural resource base. However, it does appear that the successful development of a Great Lakes salmon fishery will have a considerable effect especially as higher disposable incomes and a more advanced technology place larger more seaworthy boats in the hands of a bigger proportion of the boating population. However, only water oriented residential and cottage development and road access could be taken into consideration in modifying the revised 1965 attraction indices for use in the 1980 simulations.[1] These modified attraction indices and the

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[1] An account of how this was done is contained in Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

modified annual carrying capacities for each destination in 1980 were used in both 1980 simulations (see Appendix VIII).

Assumed Changes in Demand Factors

Since no detailed projections of Michigan population by county and socio-economic groups were available at the time that the 1980 boating simulations were to be undertaken, it was decided to make two sets of boating demand projections. One set was based entirely on the effects of population increase while the other attempted to also include the probable effects of other socio-economic multipliers.

Projections Based on Population Increase Only

The 1980 population projections used in the estimates of 1980 recreational boating demand are those adopted officially for the State Resource Planning Program which is directed by the Michigan Department of Commerce.[1] These projections are given by county and age groupings only. The value for the projected 1980 population for each county or pair of counties was divided by the 1965 population and the 1965 expanded boat use-period total for each origin was then

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[1]University of Michigan, Population Studies Center, Michigan Population 1960 to 1980 (Lansing, Michigan: State Resource Planning Program, Michigan Department of Commerce, January 1966), Working Paper No. 1.

multiplied by the resultant factor. The detailed values are given elsewhere.[1]

In running the RECSYS model to project the distribution of 1980 boating on the basis of increased population at the origins alone, a number of assumptions are implied. First, it is being assumed that the boating participation rate per thousand population at each origin will be the same in 1980 as it was in 1965 according to the expanded Waterways Division boating survey data. This means that it is being assumed that no increases in participation rates will occur due to increased disposable income, more leisure time, and greater mobility. The present level of demand is being maintained. This also implies that the composition of the origin populations is basically the same for both years since a substantial change in the socio-economic profile of the origin populations would probably result in a change in participation rates.

The assumptions inherent in the 1965 data and the 1965 model are also operative in the 1980 model runs. In some cases, this may cause some inaccuracies. For example, in the previously cited problem with the Detroit area residents registering their boats in Roscommon County, the amount of

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[1]Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

boating in 1980 in that county will probably be under predicted since the population increase for Roscommon is considerably smaller per thousand than in Detroit. On the other hand, the exaggerated participation rate for Roscommon due to non-resident boat registrations will be a compensating error to some extent.

Because of the fact that additional demand multipliers such as greater disposable income, increased leisure time, and more mobility are not included in this projection, it could be considered to be the lower limit of the probable amount of boating that will take place in Michigan in 1980. It is likely to represent the 1980 situation if the rate of growth of boating is slowed due to either a change in the social desirability of boating or a considerable recession. The results of this 1980 simulation will be discussed later in the chapter.

Projections Based on Population Increase and Other Factors

When the 1980 pattern of boating demand is forecast solely on the basis of population increase as described in the previous section, a number of important variables are ignored. Since the same participation rates are assumed, no allowance is being made for higher rates due to increased leisure time brought about by shorter work weeks or longer vacations. Using fixed participation rates also eliminates adjustments for the effects of larger disposable incomes. With higher purchasing power, more families are able to afford boats and bigger more powerful boats are purchased by those who are already boat owners. This increases the average number of days spent boating each year per 1000 population. Increased mobility is the other factor that increases recreation participation. In the case of boating, the ability to travel from the residence to water, and frequently the ability to transport a boat, are critical factors in participation. Again, purchasing power is significant in that the greater the disposable incomes, the more likely it is that the average prospective boater will be able to purchase the car and boat trailer he requires before he can participate.

But recreation participation rates may not continue to increase. Indeed, as Barlowe has pointed out,[1] the straight-line projection of recent high rates of increase in participation would mean that eventually we would be doing nothing else. A change in the social acceptability of a recreational activity or an economic decline could reduce participation considerably. For example, total participation in fishing in Michigan appeared to drop in the late 1950's and

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[1] Raleigh Barlowe, "Land for Recreation," Land Use Policy and Problems in the United States (Lincoln, Nebraska: University of Nebraska Press, 1963), p. 273.

early 1960's probably due to the combined effects of declining fishing quality, increased competition for water space by non-fishing recreational boats, the boom in family use of boats for cruising and waterskiing, and the rise in the social desirability of family "togetherness" which is the antithesis of father going off to fish by himself for lengthy periods.

For the following projection of boating demand to 1980, it will be assumed that the present pattern of economic progress will continue until that date. It will also be assumed that the social attitude towards boating will remain the same. The latter appears to be very likely in view of the strong innate attraction of water common to most people who like outdoor recreation activities and the fact that boating has remained a favorite activity of the wealthy and, therefore, appears unlikely to lose its social acceptance.

The problem then is to estimate the probable effect on boating participation of factors other than population increase. Unfortunately, the effect of socio-economic multipliers on the growth of boating participation rates has not been investigated in Michigan. The Michigan Outdoor Recreation Demand Study boating survey included questions on the socio-economic characteristics of respondents but since no earlier data were available it was impossible to develop any theories on the relationships between changes in these variables and changes in participation rates.[1] The Michigan Department of Conservation Waterways Division Boating Needs Survey conducted in 1966 did not include any socio-economic questions so participation growth could not be related to socio-economic changes. Even if data were available that expressed the relationships between participation and socio-economic change, such factors could not be applied to individual destinations because no detailed predictions of the socio-economic characteristics of Michigan's 1980 population are yet available.

Some sources have attempted to relate the rates of change in boating participation to changes in socio-economic characteristics. In ORRRC Study Report 26, Prospective Demand for Outdoor Recreation, a table predicts a 35.9 percent increase in the nationwide boating participation rate (other than sailing or canoeing) in the period 1960 to 1976 based on the changes likely to take place in six socio-economic factors.[2] (This is of course in terms of the participation rate per individual and therefore does not include the effect of increased population). The table also shows a break down

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[1] Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, op.cit., pp. 10.8-10.11.

[2] U.S. Outdoor Recreation Resources Review Commission, Study Report 26, Prospective Demand for Outdoor Recreation (Washington, D.C.; U.S. Government Printing Office, 1962), p. 28.

of the estimated individual effect of the six socio-economic characteristics considered. Of the 35.9 percent increase forecast, 18.2 percent is expected to be attributable to increased income, 5.1 percent to higher educational levels, .5 percent to a shift in occupations, .1 percent to changes in the age - sex ratios and 8.8 percent to increased leisure time. The sixth variable, "place of residence," was apparently not one that showed a strong influence on boating participation nationally and is said to be expected to have no general effect.

Similar predictions for the period from 1960 to 2000 A.D. show a total increase in participation of 78.9 percent with increased income contributing 31.1 percent, increased leisure time 19.4 percent, and higher education 10.1 percent.[1] These values are too general to apply to Michigan, but they do give some indication of the possible scale of the socio-economic multipliers.

This strong correlation between boating participation and income is confirmed by other studies. The analysis of MORDS boating survey data in the Tourist Study conducted by Central Michigan University indicates that:

> The average "Family" income of the boater is significantly above that of the Summer tourist's "Family" income ($9,500 vs. $8,800). Almost 39% of the boaters have

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[1] _Ibid._

> incomes over $10,000 and over 86% have an income over $6,000 per year. Over 25% of the boaters reported that they had completed from 13 to 15 years of school and 16% reported that they had finished college.[1]

This study also indicates a high proportion of professional and managerial occupations among boat owners. Some 22.5 percent were in the "professional - technical" classification, 24.9 percent were "manager - owners" and 19.8 percent were "craftsmen - foremen."[2] The 1962 California boating study showed a somewhat similar distribution of boat owners within the various income classes but the proportions in each class were slightly lower.[3]

Having established that participation in boating appears to be strongly correlated to income and less strongly affected by the amount of leisure time, the problem is to develop factors for the probable increase in boating participation between 1965 and 1980 due to all the socio-economic multipliers.

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[1]Central Michigan University, Center for Economic Expansion and Technical Assistance, Michigan Tourism (Mount Pleasant, Michigan: Central Michigan University, 1966), Vol. II, p. 10.

[2]*Ibid.*, p. 134.

[3]Lee, Hill, and Jewett, Inc., California Small Craft Harbors and Facilities Plan, Comprehensive Report (San Fransisco, California: Lee, Hill, and Jewett, Inc., March 1964), p. B-37.

All indications suggest that Michigan will continue to experience a substantial growth in both the proportion of "white collar workers" employed and in the average annual wage. The Michigan Manpower Study forecasts that there will be 1.8 times as many "white collar workers" in the state in 1980 as there will be "blue-collar workers" while in 1960 the two groups were almost equal in size.[1] "Exceptional employment growth is predicted for civil engineers (4.0 percent per year between 1960 and 1980), electrical engineers (4.9 percent), medical and dental technicians (6.0 percent), electrical and electronic technicians (6.5 percent) and other engineering and physical sciences technicians (5.6 percent).[2] It is also predicted that the average Michigan resident over 25 will have received two more years of formal education by 1980, than he did in 1965.[3]

From these indications and under the assumptions of no major depression or substantial change in the social desira-

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[1]Battelle Memorial Institute, Michigan Manpower Study (Columbus, Ohio: Battelle Memorial Institute, November 1966), p. S-7.

[2]*Ibid.*, p. S-5.

[3]David N. Milstein, Michigan's Outdoor Recreation and Tourism (East Lansing, Michigan: Michigan State University, 1966), (A Research Report in the Project 80 series), p.1.

bility of boating stated earlier, it appears reasonable to assume that total boating participation will continue to grow at approximately the same rate as it did during the years between 1960 and 1965 provided limitations on the supply of boating waters do not have a discouraging effect. This last problem will be discussed later in the analysis of the RECSYS-SYMAP runs.

The question remains, how much growth in boating participation is taking place and will take place by 1980 and how will it be distributed spatially? At present, there are no good indications of the growth of boating in Michigan.[1] The boat registration procedures administered by the Secretary of State's office have not produced reliable data due to the three year period of registration and the problem of boats that are destroyed or scrapped. However, these data do give some indication of growth. The total registrations in 1963, 1964 and 1965 were 314,438, 361,112, and 398,902 respectively. This represents a 14.9 percent increase in registrations from 1963 to 1964 and a 10.5 percent increase

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[1] Both national and state boat manufacturing and retailing organizations were contacted but no exact data were available. It was discovered that most state figures quoted by such organizations are crude estimates which are of doubtful value except when aggregated to give national estimates.

from 1964 to 1965.[1] In contrast, the total increase in boat use-periods between 1964 and 1965 was from 11,420,000 to 15,592,000 as revealed by comparison of the MORDS boating survey and the Waterways Division boating study (see Appendix II). This represents an increase of 4,172,000 or 36.6 percent over the 1964 total. However, as was pointed out previously, the MORDS survey is suspect in the matter of boating use because of problems with the questions.

In order to be able to proceed with 1980 projections, it was decided to assume that the average of the 1964 and 1965 boating registration percentage increases or a value of 12.7 percent per year represents the average increase in the number of registered boats. However, in this increase there are two components. They are, the increase due to added population and the increase due to a higher level of participation. Since the Michigan population appears to have been increasing at the rate of between .85 and 1.3 percent during the first half of the decade, it will be assumed that of the 12.7 percent increase only one percent can be attributed to population increase alone. This means that some 11.7 percent of the increase can probably be said to be due

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[1] Some of the difficulties encountered in interpreting the boat registration data are discussed in Waterways Division report presently in preparation cited on page 29.

to changes in the socio-economic factors involved, no doubt primarily the increase in family disposable incomes.

At this point it should be emphasized that the increase in registrations does not give any indication of the increase in use of individual boats due to more leisure time, increased income and other factors. A well-documented indicator of the type of increases in total use presently being experienced in outdoor recreation is the 11.1 percent per year average increase in Michigan state park camping attendance between 1950 and 1965.[1] Part of such increases is due to increased population, part to more people being able to participate due to increased income and greater leisure time, and part because of a higher average participation by all users.

From these indicators, it appears that it is not unreasonable to estimate that from 1964 to 1965 there was at least a 15 percent increase in the amount of boating undertaken in Michigan due to new and increased participation only with no allowance for increased population. This 15 percent increase is suggested on the basis of a probable ten percent increase in the number of boats and a five percent increase

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[1] Michigan State University, Department of Resource Development, Michigan Outdoor Recreation Demand Study, *op.cit.*, p. 6.13.

in the amount of boating done in each boat. If such a rate of increase were to continue until 1980, the results would be staggering. There would be some 1,666,000 registered boats in the state (or about one boat for every six persons), and the total use would be 125,000,000 boat use-periods per year. These values are increases of 420 percent and 930 percent respectively.

Clearly, such a high rate of increase is not likely to continue. It appears more likely that the rate of increase, exclusive of population increase effects, will gradually decrease as a greater proportion of the population acquires boats and boating waters become more crowded. Since this situation has not existed previously, it is not possible to rely on earlier trends. It has, therefore, been assumed that the rate of increase will decrease and this decrease will amount to one percent per year so that in 1980 the participation rate will have become reasonably stable and the main increase in total participation will be due to population increase. This would result in a statewide total participation by in-state registered boaters of 44 million boat use-periods in 1980 (an increase of 283.0% from the 1965 value) and a participation rate of about 5.4 boat use-periods per person per year compared to 2.45 boat use-periods per year in 1965.[1]

[1] Supra., Appendix II.

These values appear to be quite reasonable and even a little conservative in the light of recent boating growth rates.

Clearly, the uniform application of the same participation rate to all origin populations would result in a distorted pattern of use since it has been demonstrated that participation rates appear to vary considerably from county to county.[1] Therefore, it was decided to increase or decrease the 5.4 use-periods rate for each origin by the percentage that the 1965 rate deviated from the 1965 average rate for the state. This was done on the assumption that the basic pattern of the influences that will affect boating participation in 1980 will be the same as in 1965 and, therefore, the pattern of 1980 participation rates is likely to be similar to the 1965 pattern.[2]

There is one other major factor which will probably bring about a considerable change in the pattern of boating use in Michigan, but which has not yet been considered in this analysis. It is the probable establishment of a successful Great Lakes salmon fishery. This variable is so definitely a major aspect of the fishing supply and demand

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[1] _Ibid._

[2] The calculation of the assumed 1980 participation rates with a 10% increase to allow for unregistered boats and the resultant actual origin loading values are shown in Appendix XI.

situation, it appears that the best approach is to include it as a factor in the 1980 RECSYS-SYMAP fishing simulations at a later date and then use the predictions of fishing demand to arrive at values for the additional boating demand that is likely to result.

Simulation and Mapping of 1980 Demand, Supply, Needs and Surplus

Simulation Based on Population Increase and Highway Changes Only

The initial 1980 simulation utilized highway changes[1] and population growth only as described earlier. The individual origin loading values for 1980 based on increased population only are shown elsewhere.[2]

The results of this simulation are given in Table 9 and a SYMAP reproduction in Figure 9 shows the spatial distribution of demand. When this map is compared to Figure 3, it is seen that there has been little change in the general pattern of demand. Because of this, the pattern of boating supply surplus also changed little but did have lower values.

It is clear from this simulation that the state faces no major boating supply problems by 1980 if only population

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[1]See Appendix IX.

[2]Chubb, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part III, op.cit.

Table 9. Results of 1980 Simulation Using Population Increase and Changes in Highway Links Only, Showing Resultant Demand

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods: Demand[b]	Boat Use-Periods: Supply[c]	Boat Use-Periods: Surplus[d]
901	Baraga	9.71	46,503	2,078,000	2,031,507
902	Gogebic	3.34	120,566	3,225,900	3,105,334
903	Houghton	7.95	115,893	2,542,400	2,426,507
904	Keweenaw	-1.56	4,606	2,137,500	2,132,894
905	Ontonagon	-12.61	24,524	1,674,300	1,649,776
906	Dickinson	8.27	87.216	453,600	366,384
907	Iron	15.49	107,959	1,771,200	1,663,241
908	Menominee	7.37	130,226	1,365,400	1,235,174
909	Alger	-27.24	35,131	3,302,400	3,267,269
910	Delta	21.14	126,742	3,521,800	3,395,058
911	Marquette	24.74	151,099	4,144,900	3,993,801
912	Chippewa	-2.83	117,769	8,065,700	7,947,931
913	Luce	-3.44	22,992	1,667,600	1,644,608
914	Mackinac	-9.06	192,318	5,773,700	5,581,382
915	Schoolcraft	-9.49	80,161	3,210,200	3,130,039
916	Alpena	18.54	142,482	2,974,600	2,832,118
917	Antrim	23.10	223,419	2,776,300	2,552,881
918	Charlevoix	24.74	152,430	5,257,800	5,105,370
919	Cheboygan	14.10	362,223	5,366,900	5,004,677
920	Emmet	14.74	52,456	1,629,800	1,577,344

Table 9—Continued

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods Demand[b]	Boat Use-Periods Supply[c]	Boat Use-Periods Surplus[d]
921	Montmorency	25.26	128,442	828,000	699,558
922	Otsego	28.12	165,276	482,400	317,124
923	Presque Isle	-30.34	131,131	1,008,000	876,869
924	Benzie	25.66	165,173	2,064,900	1,899,727
925	Grand Traverse	27.12	451,264	2,039,800	1,588,536
926	Leelanau	41.06	213,816	3,653,500	3,439,684
927	Lake	17.32	145,845	309,600	163,745
928	Mason	20.67	167,713	1,472,900	1,305,187
929	Manistee	23.01	126,081	1,295,000	1,168,919
930	Newaygo	15.74	478,281	828,000	349,719
931	Oceana	13.21	128,087	1,025,200	897,113
932	Wexford	31.27	166,990	468,000	301,010
933	Alcona	37.08	214,522	1,679,900	1,465,378
934	Crawford	35.63	49,179	180,000	130,821
935	Iosco	36.55	535,312	1,713,800	1,178,488
936	Kalkaska-Miss.	35.79	258,056	892,000	633,944
937	Og.-Oscoda	41.36	386,625	833,600	446,975
938	Roscommon	41.23	704,544	2,815,200	2,110,656
939	Arenac	27.04	92,681	1,010,800	918,119
940	Bay	20.33	238,849	1,842,200	1,603,351
941	Clare-Glad.	23.82	524,501	871,200	346,699
942	Isabella	21.89	48,806	79,200	30,394
943	Midland	19.45	73,466	180,000	106,534
944	Mec.-Osceola	22.44	364,989	799,200	433,211
945	Kent	14.57	422,819	576,000	153,181

Table 9—Continued

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods		
			Demand[b]	Supply[c]	Surplus[d]
946	Ionia-Mont.	18.29	426,569	648,000	221,431
947	Muskegon	14.49	325,201	1,559,400	1,234,199
948	Ottawa	13.97	523,470	1,094,700	571,230
949	Clinton-Grat.	20.86	31,972	158,400	126,428
950	Eaton-Ingham	15.12	81,603	108,000	26,397
951	Livingston	16.46	647.711	662,400	14,689
952	Saginaw	13.44	33,372	100,800	67,328
953	Shiawassee	15.00	12,510	64,800	52,290
954	Gen.-Lapeer	20.94	672,296	698,400	26,104
955	Huron	16.02	270,338	2,942,600	2,672,262
956	St. Clair	23.52	1,040,226	2,476,100	1,435,834
957	Sanilac	18.11	51,452	1,093,200	1,041,748
958	Tuscola	15.68	114,886	637,200	522,314
959	Allegan	12.92	294,532	1,289,100	993,568
960	Barry	14.62	715,017	748,800	33,783
961	Berrien	13.76	355,190	1,441,100	1,085,910
962	Cass-St. Joseph	16.00	977,713	1,339,200	361,487
963	Kalamazoo	13.50	400,739	698,400	297,661
964	Van Buren	14.27	440,294	821,300	381,006
965	Branch-Calhoun	22.17	744,917	921,600	176,683
966	Hillsdale-Len.	17.31	547,119	686,800	139,681
967	Jackson	17.23	590,111	705,600	115,489
968	Monroe	13.49	330,501	1,090,500	759,999
969	Washtenaw	17.59	480,434	640,800	160,366
970	Macomb	21.51	1,187,036	1,085,400	-101,636

Table 9—Continued

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods		
			Demand[b]	Supply[c]	Surplus[d]
971	Oakland	22.60	1,449,874	1,656,000	206,126
972	Wayne	20.42	1,396,074	1,825,400	429,326
	TOTALS		22,820,320	119,082,400	96,259,940

[a]Percent increase in demand over value obtained in 1965 simulation.

[b]"Demand" is value obtained in 1980 simulation using changes in population and highway links only, and corrected in accordance with percent errors obtained in final tuning run.

[c]"Supply" is the 1965 capacity value—see Appendix VII.

[d]"Surplus" is the amount by which "Supply" exceeds "Demand."

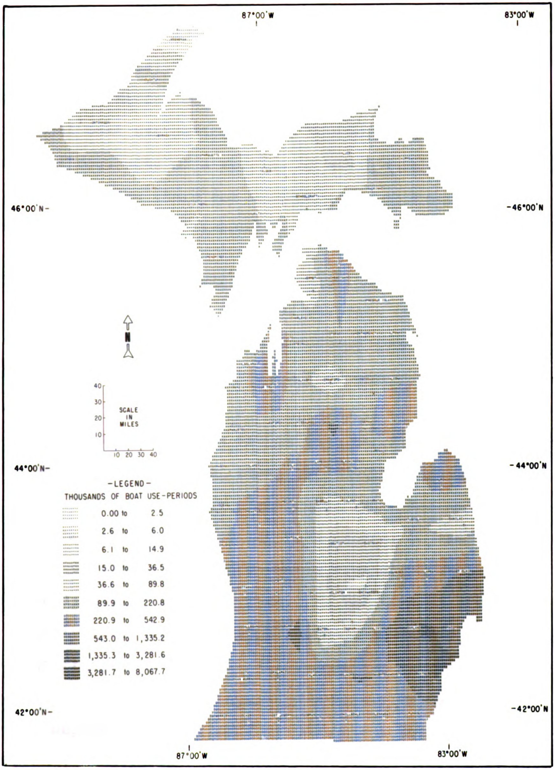

Figure 9. Choropleth Map of 1980 Boating Demand at Michigan Destination Counties Based on Population Growth and Highway Changes Only

increases and highway improvements influence the quantity of boating undertaken and the supply of boating opportunities remains substantially the same. The only actual deficit area would be Macomb County which would need some 100,000 additional boat use-periods. If, however, the previously discussed requisite of a surplus of 200,000 boat use-periods is observed, then there are sixteen other destinations which can be said to have an inadequate supply.

Simulation with Participation Increase Included

The origin loading data for the full 1980 simulation developed as described earlier were used (see Appendix XI). The same 1980 highway link values were employed (see Appendix IX).

The attraction index values were modified to some degree (see Appendix VIII). Where the destination was endowed with a good number of fair sized lakes in a national or state forest, the index was increased by 5 percent on the assumption that development of more public access and facilities would be likely to occur by 1980. In the case of a destination county that had many large lakes or extensive river frontage fringed by substantial residential or resort development, the index was increased by a factor of from 5 to 20 percent depending on the apparent potential for further development. The index for Alger County was increased by five percent as a token of the probable effect of the development of the Pictured Rocks National Lakeshore. The counties which are likely to be included in the Department of Conservation's artificial lakes program were given a 5 to 20 percent increase in the value of their attraction indices depending on the type and extent of their existing lakes. (In these counties the capacity was also increased by the amounts shown in Table 8). The same scaling constants were used as were employed in the 1965 simulation.

The projections of 1980 boating demand for each destination produced by this simulation were then increased or decreased by the percent error values obtained in Run 18 (see Table 3). The resultant corrected estimates are given in column "b" of Table 10. Note that the total statewide demand is projected to be 51,241,000 boat use-periods or an increase equal to 222 percent of the 1965 figure. The actual individual percentage increases for each destination are shown in column "a."

As in the two previous simulations, the estimated demand was subtracted from the supply in order to calculate the surplus supply or, where the demand was the larger value, the supply was subtracted from it in order to calculate the additional supply needed to entirely satisfy the demand. The demand, supply, surplus, and needs values are all given in

Table 10. Results of 1980 Simulation Using Changes in Population, Participation, Highway Links, and Attraction, Showing Resultant Demand

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods: Demand[b]	Supply[c]	Needs[d]	Surplus[e]
901	Baraga	147.12	104,745	2,078,000	-	1,973,255
902	Gogebic	121.50	258,769	3,225,900	-	2,967,131
903	Houghton	152.83	271,426	2,542,400	-	2,270,974
904	Keweenaw	121.78	10,377	2,137,500	-	2,127,123
905	Ontonagon	95.02	54,728	1,674,300	-	1,619,572
906	Dickinson	157.17	207,165	453,600	-	246,435
907	Iron	180.21	261,946	1,771,200	-	1,509,254
908	Menominee	177.12	336,121	1,365,400	-	1,029,279
909	Alger	75.98	84,971	3,302,400	-	3,217,429
910	Delta	187.15	300,428	3,521,800	-	3,221,372
911	Marquette	200.32	363,797	4,144,900	-	3,781,103
912	Chippewa	108.95	253,247	8,065,700	-	7,812,453
913	Luce	110.41	50,098	1,667,600	-	1,617,502
914	Mackinac	96.95	416,530	5,773,700	-	5,357,170
915	Schoolcraft	98.23	175,565	3,210,200	-	3,034,635
916	Alpena	134.79	282,221	2,974,600	-	2,692,379
917	Antrim	150,44	454,525	2,776,300	-	2,321,775
918	Charlevoix	165.97	325,021	5,257,800	-	4,932,779
919	Cheboygan	147.07	784,381	5,366,900	-	4,582,519
920	Emmet	149.22	113,937	1,629,800	-	1,515,863
921	Montmorency	155.12	261,608	828,000	-	566,392
922	Otsego	155.06	329,037	482,400	-	153,363
923	Presque Isle	44.60	272,220	1,008,000	-	735,780
924	Benzie	186.96	377,194	2,064,900	-	1,687,706
925	Grand Traverse	172.71	968,088	2,039,800	-	1,071,712

Table 10--Continued

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods			
			Demand[b]	Supply[c]	Needs[d]	Surplus[e]
926	Leelanau	179.63	423,854	3,653,500	-	3,229,646
927	Lake	148.83	309,340	309,600	-	260
928	Mason	155.87	355,634	1,472,900	-	1,117,266
929	Manistee	168.28	274,981	1,295,000	-	1,020,019
930	Newaygo	157.99	1,066,111	828,000	238,111	-
931	Oceana	122.56	251,803	1,025,200	-	773,397
932	Wexford	185.47	363,157	468,000	-	104,843
933	Alcona	188.51	451,513	1,679,900	-	1,228,387
934	Crawford	144.72	88,732	180,000	-	91,268
935	Iosco	188.54	1,131,139	1,713,800	-	582,661
936	Kalkaska-Miss.	158.14	490,592	892,000	-	401,408
937	Og.-Oscoda	190.28	793,897	833,600	-	39,703
938	Roscommon	206.08	1,527,875	2,815,200	-	1,287,325
939	Arenac	150.47	182,724	1,010,800	-	828,076
940	Bay	139.28	474,954	1,842,200	-	1,367,246
941	Clare-Glad.	158.82	1,096,386	871,200	225,186	-
942	Isabella	279.47	151,938	122,400	29,538	-
943	Midland	237.92	207,830	237,600	-	29,770
944	Mec.-Osceola	181.01	837,715	799,200	38,515	-
945	Kent	162.63	969,272	576,000	393,272	-
946	Ionia-Mont.	176.80	998,180	299,780	299,780	-
947	Muskegon	152.97	718,575	1,559,400	-	840,825
948	Ottawa	141.36	1,108,602	1,094,700	13,902	-
949	Clinton-Gratiot	356.76	120,832	223,200	-	102,368
950	Eaton-Ingham	332.88	306,856	158,400	148,456	-

Table 10--Continued

Code No.	Destination	Percent Increase In Demand[a]	Boat Use-Periods			
			Demand[b]	Supply[c]	Needs[d]	Surplus[e]
951	Livingston	183.93	1,579,109	662,400	916,709	-
952	Saginaw	293.99	115,900	136,800	-	20,900
953	Shiawassee	385.87	52,853	108,000	-	55,147
954	Gen.-Lapeer	197.74	1,655,125	712,800	942,325	-
955	Huron	154.36	592,685	2,942,600	-	2,348,915
956	St. Clair	172.81	2,297,421	2,476,100	-	178,679
957	Sanilac	136.80	103,156	1,093,200	-	990,044
958	Tuscola	131.68	230,101	637,200	-	407,099
959	Allegan	152.39	658,330	1,289,100	-	630,770
960	Barry	179.37	1,742,708	748,800	993,908	-
961	Berrien	163.97	824,166	1,441,100	-	616,034
962	Cass-St. Joseph	181.89	2,375,918	1,339,200	1,036,718	-
963	Kalamazoo	176.36	975,752	698,400	277,352	-
964	Van Buren	171.40	1,045,691	821,300	224,391	-
965	Branch-Calhoun	198.59	1,820,620	921,600	899,020	-
966	Hillsdale-Len.	161.16	1,218,052	686,800	531,252	-
967	Jackson	187.43	1,446,827	705,600	741,227	-
968	Monroe	143.90	710,248	1,090,500	-	380,252
969	Washtenaw	140.09	980,912	640,800	340,112	-
970	Macomb	149.35	2,435,861	1,085,400	1,350,461	-
971	Oakland	193.11	3,466,455	1,656,000	1,810,455	-
972	Wayne	149.48	2,892,416	1,825,400	1,067,016	-
	TOTALS		51,240,943	119,082,400	12,517,706	80,718,163

[a]Percent increase in demand over value obtained in 1965 simulation.

[b]"Demand" is value obtained in 1980 simulation using assumed changes in origin populations, participation rates, highway links and destination attraction, corrected in accordance with percent errors obtained in final tuning run.

[c]"Supply" is the 1980 capacity value--See Appendix VIII.

[d]"Needs" is the amount by which "Demand" exceeds "Supply."

[e]"Surplus" is the amount by which "Supply" exceeds "Demand."

Table 10. Four separate SYMAP programs were then run, one for each of these sets of values. The same left-hand expanded logarithmic scaling employed in the earlier simulations was used. The choropleth maps for each of the four phenomena were mounted and photographically reproduced to form the illustrations in this chapter. The isopleth maps are not included since this type of map was found to be less useful in the regionalization of 1965 demand, supply, and surplus.[1]

Regionalization of Demand, Supply, Needs and Surplus

1980 Boating Demand

In Figure 10, the choropleth map of 1980 demand, a region of high demand occupies the southern third of the state except for a large central area caused by a lower level of demand being experienced in the "lakeless" area discussed earlier.[2] This high demand area designated as Region I is about six times larger than the four county area covered by Region I in 1965 (see Figure 8). Other segments of Region I are beginning to appear further up the state. The region of medium - high demand, Region II, covers most of the balance

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[1]The isopleth maps were mounted and reproduced in the report for the Department of Conservation and were also consulted in developing the regionalization.

[2]*Supra.*, pp. 89-90.

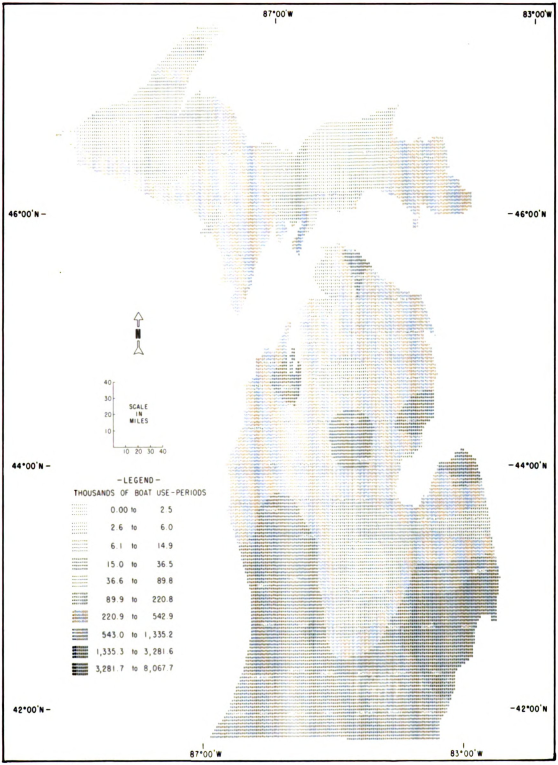

Figure 10. Choropleth Map of 1980 Boating Demand at Michigan Destination Counties Based on Increased Population, Participation Growth, and Other Multipliers

of the Lower Peninsula and nearly all of the Upper Peninsula. The region of medium - low demand, Region IV, centered around Clinton County has been replaced with a much smaller region of medium demand, Region III. The regionalization of 1980 boating demand is summarized in Table 11.

1980 Boating Supply

As discussed earlier, it appears that the supply of boating opportunities is not likely to change substantially by 1980.[1] The supply map, therefore, remains the same as in 1965 (see Figure 5) except for a small decrease in the size of Region IV, the region of medium - low supply centered about Clinton, Eaton and Ingham Counties, and, therefore, has not been reproduced.

1980 Boating Needs

The considerable increase in demand predicted for 1980 results in many areas having an insufficient supply of boating opportunities to satisfy demand. Consequently, these areas need an additional supply of boating resources as shown in Figure 11. The lowest level of shading includes zero need which has been entered where the destination concerned had a surplus of boating opportunities. The boating supply need areas are shown as five regions on Map C in Figure 13. The characteristics of these regions are summarized in Table 12.

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[1] *Ibid.*

Table 11. List of Boating Destination Demand Regions for 1980

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Demand	Over 543.0	A large area involving some 28 counties in southern Michigan. Also five satellite areas in Grand Traverse, Roscommon, Iosco, Huron, and Cheboygan Counties
II	Medium - High Demand	89.9 to 542.9	The remainder of the Lower Peninsula except for one small area; all of the Upper Peninsula except for three small areas
III	Medium Demand	36.6 to 89.8	A small area in Clinton, Shiawassee, Saginaw, and Gratiot Counties; most of Luce County, and the northern part of Ontonagon
IV	Medium - Low Demand	6.1 to 89.8	The northern part of the Keweenaw Peninsula

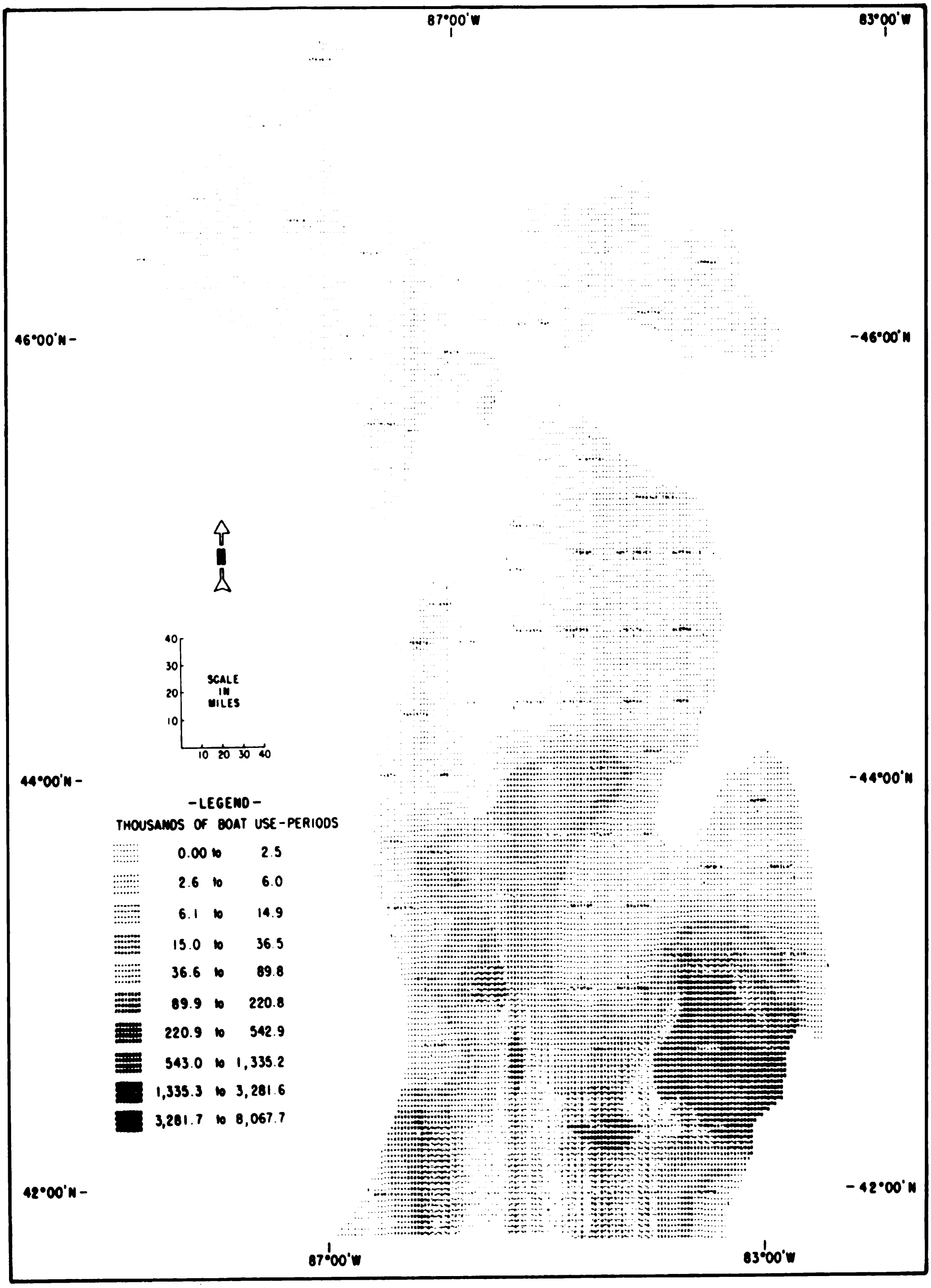

Figure 11. Choropleth Map of 1980 Boating Supply Needs by Michigan Destination Counties

Table 12. List of Boating Supply Needs Regions for 1980

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Needs	1,335.3 to 8,067.7	A small region in southern Macomb and Oakland Counties
II	Medium - High Needs	543.0 to 1,335.2	Surrounds Region I including parts of Macomb, Lapeer, Genesse, Livingston and Wayne Counties plus the rest of Oakland. Small area in Jackson County
III	Medium Needs	89.9 to 542.9	A substantial part of the inland section of southern Michigan involving the first four tiers of counties
IV	Medium - Low Needs	15.0 to 89.8	A belt across the southern part of the state above Region III. It enlarges into a northward pointing protrusion covering Mecosta, Isabella, Clare and Gladwin Counties
V	Low Needs	2.6 to 14.9	Another belt across the state following the outer edge of Region IV

1980 Boating Surplus

The SYMAP print-out for the surplus supply of boating opportunities in 1980 is shown in Figure 12. A zero value was entered in the data deck for all those destinations where the supply did not exceed the demand. This means that the lowest level of shading includes areas that have no surplus or are actually shown in Figure 11 as destinations needing additional boating opportunities. The areas with a surplus of boating opportunities have been divided into five regions as shown on Map D of Figure 13 and listed in Table 13.

Differences and Similarities, 1965-1980

A comparison of the 1980 simulation results with those of 1965 reveals the following significant points:

1. By 1980, the southern third of the Lower Peninsula will constitute an area of extremely high boating demand while in 1965 only the four county Detroit metropolitan area was in this category.

2. There will have been little significant change in the supply of boating opportunities by 1980 even in the region selected for the artificial lakes program.

3. A zone where additional boating facilities are needed which was not present in 1965, will have developed over much of the southern third of Lower Michigan by 1980. The need will be greatest in the Detroit metropolitan area, in Jackson County, and in parts of Barry and Eaton counties.

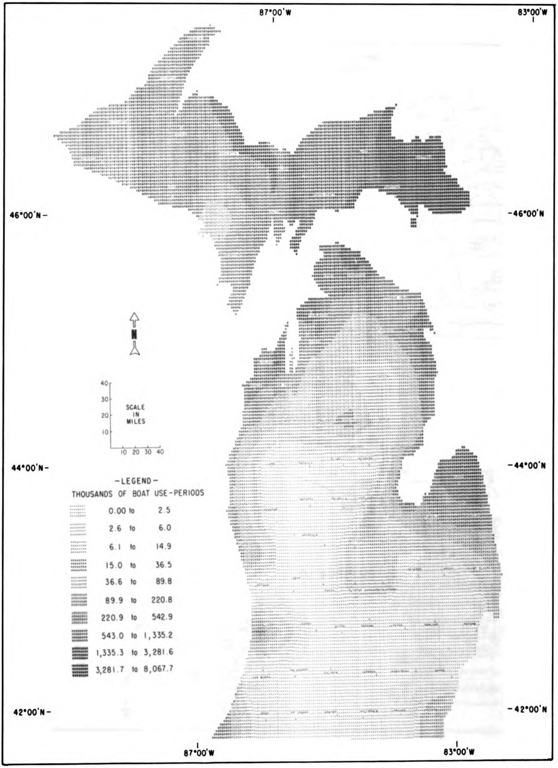

Figure 12. Choropleth Map of 1980 Boating Supply Surplus by Michigan Destination Counties

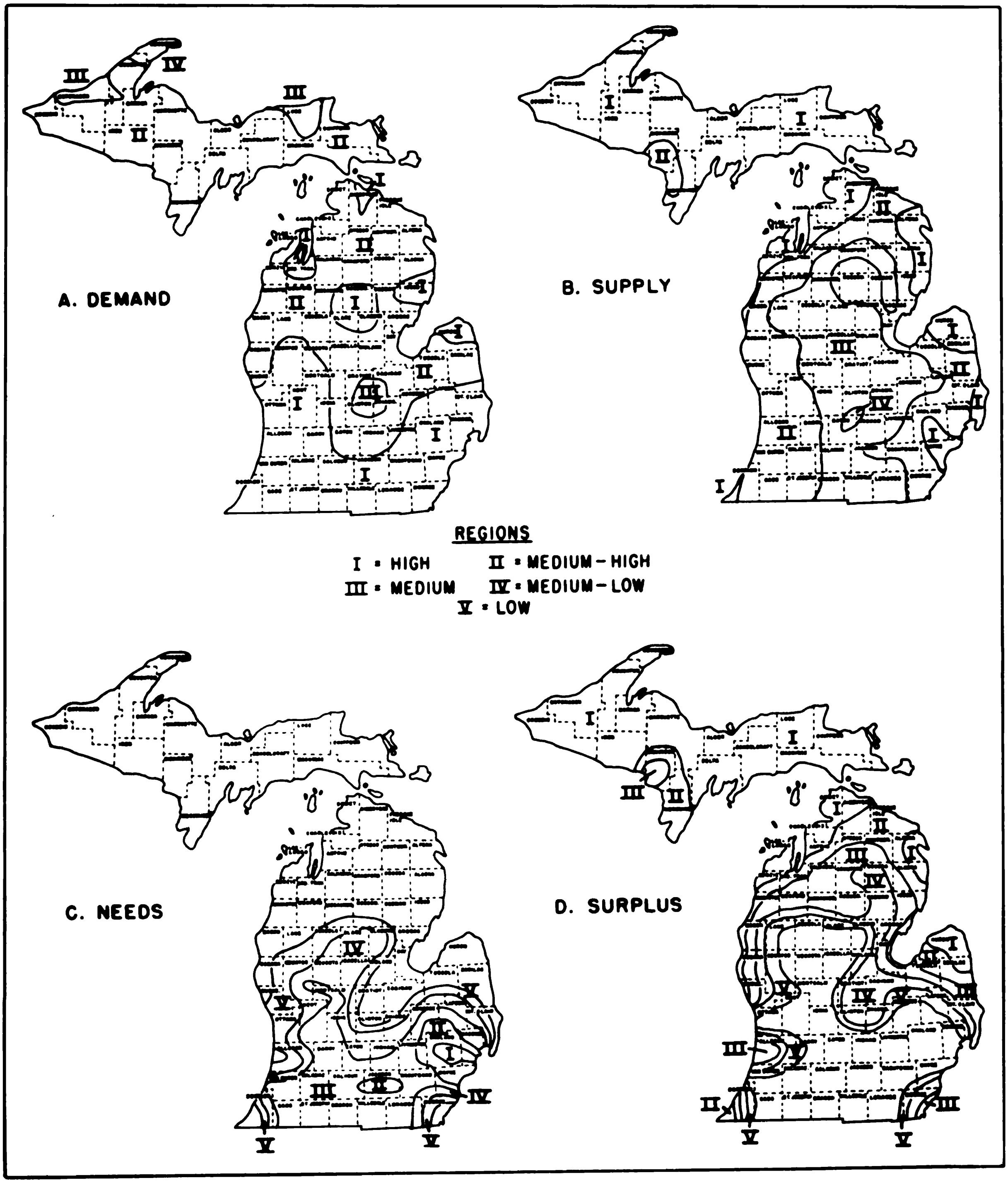

Figure 13. Generalized Maps of Demand, Supply, Needs, and Surplus Regions in 1980

Table 13. List of Boating Supply Surplus Regions for 1980

Region	Characteristic	Limits in Thousands of Boat Use-Periods	Area
I	High Surplus	1,335.3 to 8,067.7	Most of the Upper Peninsula except for an area centered around Dickinson and Menominee Counties. The northwest corner of Lower Michigan and parts of Alpena and Alcona Counties. The N.E. part of the "thumb."
II	Medium - High Surplus	543.0 to 1,335.2	A belt around the upper half of the Lower Peninsula and across the base of the thumb
III	Medium Surplus	89.9 to 542.9	A belt of varying width across the middle and upper part of Lower Michigan which broadens out into a wide zone in Kalkaska, Crawford and Roscommon Counties
IV	Medium - Low Surplus	15.0 to 89.8	Another irregularly shaped belt across the state with major enlargements into a five county area around Saginaw County and into Ogemow and Oscoda Counties
V	Low Surplus	2.6 to 14.9	A fourth belt around and across the center of the Lower Peninsula

4. An area with no surplus boating opportunities will have developed in the southern third of the Lower Peninsula and much of the northern section of Lower Michigan will have a low surplus in 1980. In contrast, all of Michigan had a surplus in 1965 and about one-fifth of the State had a high or medium - high surplus at that time.

CHAPTER V

SUMMARY AND CONCLUSIONS

Performance of the Systems Model Technique

The procedures and results described in the previous chapters have shown that the RECSYS-SYMAP approach does demonstrate the probable future spatial distribution of recreation demand, supply, needs and surplus and thus is a valuable tool in the statewide recreation planning. The technique has been shown to fulfill the specifications for an ideal method contained in Chapter I to a very large degree. In particular, the test of the technique by means of the boating case study has clearly indicated that the following main specifications are fulfilled. The method:

1. -is basically realistic since it is an actual mathematical model with all the major components of the recreation system represented quantitatively and in their correct spatial relationships.

2. -can be applied to all the recreation activity groupings established.

3. -in its present form, uses origin and destinations that are small enough to give sufficient areal differentiation to be of great value in statewide recreation planning.

4. -assures that the estimation of the probable present and future distribution of recreation demand is likely to be accurate since it is based on the actual measurement of the use of individual destinations by residents of each origin.

5. -is structured so that its accuracy in estimating the probable magnitude and distribution of present and future recreation demand, needs, and surplus is enhanced by the fact that all the participation pressures are applied to the system simultaneously and the various components interact in a spatial context.

6. -can relate supply to demand in a direct mathematical manner since both parameters are expressed in the same units.

7. -is fast and easily repeatable.

8. -requires a minimum of judgment because a fixed computer program is used to estimate the probable spatial distribution of demand.

9. -produces tabulations and maps that can be used directly in publications and presentations.

10. -can be carried out by comparatively low level technical staff once it is designed and tested.

However, the RECSYS-SYMAP technique has some serious drawbacks as was demonstrated in the case-study. The main disadvantages are as follows:

1. The technique requires a large amount of precise data on supply and demand which can normally

only be obtained by special surveys.[1] This is a problem common to all reasonably realistic statewide recreation planning methods.

2. The designing and testing of a RECSYS-SYMAP process requires highly specialized personnel that are not universally available.

3. The running of the RECSYS-SYMAP programs requires sophisticated computer facilities.

Reliability of Demand Distribution Projections

It is obviously not possible to judge absolutely the accuracy of the RECSYS-SYMAP process of predicting recreation demand distribution. Such judgment will only be possible if an inventory of actual boating demand is done during the year for which demand has been projected. It should also be pointed out if the RECSYS model is as realistic as it appears to be, the greatest source of error will be in the data that are fed into it. As has been demonstrated, the greatest changes in demand will occur because of changes in participation rates rather than because of increases in population.

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[1]In the many months of research associated with this thesis, at least half the time was spent on reviewing possible information sources and attempting to manipulate data so they could be used in the RECSYS simulation. It appears that the problem of obtaining adequate data will only be solved when the gathering of annual recreation statistics is carefully co-ordinated throughout the various agencies concerned and specifically designed to give the essential information.

No matter which technique is used, the accuracy of predictions of future demand depend on our ability to predict what factors will control participation and by what amount. No organization in Michigan is yet attempting to gathering annual recreation use statistics in a way that can begin to shed light on the identity and functioning of these influences. In order to estimate possible future participation the statewide recreation planner needs to know such things as the probable effect of rising income; will it gradually mean more "country club" type recreation participation and less participation in activities such as camping, fishing and boating? Will we have a shorter work-week which would mean heavier use of more distant recreation resources or is a shorter work-day more likely which will probably result in increased use of city and suburban park areas? There are many questions of this kind which can only be answered with some degree of assurance if frequent demand studies involving careful analysis of the socio-economic characteristics and preferences of the users are undertaken.

But the purpose of this project was not to determine the absolute accuracy of the RECSYS-SYMAP simulation of boating demand in 1980. Rather, it was to test the approach to see if it appeared to adequately predict demand, relate demand to supply in a numberical manner in order to indicate

needs, and show the spatial distribution of these parameters in a significant manner. It is contended that it has been demonstrated adequately that the RECSYS-SYMAP technique does indeed perform all these functions in a reasonably satisfactory way.[1]

Validity of the Case Study

At the beginning of this thesis it was hypothesized that the proposed RECSYS-SYMAP analysis of boating in Michigan would test the technique and indicate its probable reliability and potential in planning the allocation of resources for the development of all types of outdoor recreation facilities. As indicated earlier, there were a number of reasons for selecting boating for this case study not the least of which was the availability of statewide use data by origin and destination. However, it appears that boating was a good activity to select in that it was possible to calibrate and tune the model so that it gave demand predictions that closely approximated the observed values.

Certainly the first part of the hypothesis has been shown to be correct in that it was possible to test the

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[1]Some comments on the performance of SYMAP and on the possible future development and application of RECSYS are contained in Appendix XII.

RECSYS-SYMAP technique by using boating in a case study. The second part of the hypothesis is not as clearly proven. As indicated in the previous section of this chapter, the reliability of the technique is entirely dependent on how closely future recreation activity preferences and behavior resemble the present day preferences and behavior on which the model tuning is based. Using boating as a case study does appear to have demonstrated that the technique is probably reasonably reliable if the patterns of recreation preferences and behavior remain much the same in the future and our estimates of the rate of change in participation are approximately correct.

Finally, using boating as a case study has indicated the potential of the technique for planning the allocation of resources for all types of outdoor recreation activities and facilities. There appears to be no reason why any of the other eleven basic outdoor recreation activity groupings could not be analysed in a similar manner if the necessary use data and growth predictions were available. As pointed out earlier, there will probably have to be some modifications in the technique if activities such as "playing sports" are to be analysed because the county to county construction will not give sufficient detail. On the other hand, it appears that the technique will perform even more satisfactorily for

most of the other activities. For example, in the case of sightseeing, picnicking, hunting, camping, and winter sports, it is probable that there will be fewer difficulties in applying the technique if relatively good basic use data are provided. In these cases the researcher would not have to face problems such as the determination of the contribution of the Great Lakes to the supply of opportunities and the factors affecting user preferences are much better known than in the case of boating. It is concluded, therefore, that the hypothesis has been proved to be correct in that the boating case study did test the technique adequately, indicate its potential for use in planning resource allocation for other recreation activities.

Spatial Distribution of Boating Parameters in 1965

The analysis and regionalization carried out in Chapter III indicates the following distribution of boating supply, demand, and supply surplus in 1965:

1. Boating demand was concentrated in the Detroit area particularly in Wayne, Oakland, Macomb and St. Clair counties.

2. Boating demand was at a medium - high level throughout the rest of Lower Michigan except for a zone across the comparatively "lakeless" area southwest of Saginaw Bay.

3. Boating supply was highest in the Upper Peninsula and around the shoreline of Lower Michigan.

4. A region of very low supply exists in the "lakeless" area, particularly parts of Clinton, Shiawassee, Eaton and Ingham counties.

5. During 1965 the total annual demand for boating opportunities did not reach or exceed the supply in any county in the State but there was a large region with a very low surplus centered about the Clinton County "lakeless" area. Much of the remainder of southern Michigan was in a region of medium - low surplus.

6. The Upper Peninsula and certain Great Lakes counties in the upper part of Lower Michigan had a high surplus of boating opportunities as did Huron County in the "thumb."

Spatial Distribution of Boating Parameters in 1980

The analysis and regionalization carried out in Chapter IV indicates the following probable distribution of boating supply, demand, needs, and supply surplus in 1980:

1. The region of high demand will have spread from the four county area around Detroit to cover all or part of twenty-eight counties constituting approximately one quarter of the State.

2. Areas of high demand will also appear in Grand Traverse, Cheboygan, Isoco, Roscommon and Huron Counties.

3. The Upper Peninsula will have become almost exclusively a medium - high demand region.

4. The "lakeless" area will have medium demand unless the supply of water surface there is substantially increased.

5. The proposed addition of water surface under the Department of Conservation's artificial lakes program will have made little difference to the overall supply of boating opportunities in the "dry area" and the general boating supply situation in 1980 will be approximately the same as in 1965.

6. The much greater demand in 1980 will result in additional supplies of boating opportunities be needed in all the counties in the southern half of Lower Michigan.[1] Areas with high or medium - high needs will exist in the vicinity of Detroit, in Jackson County and in Barry and Eaton counties.

7. The northern half of the Lower Peninsula and all of the Upper Peninsula will still have a surplus of boating opportunities.

Measures Necessary to Improve the Spatial Imbalance Between Boating Supply and Demand

From the above analysis it is evident that by 1980 there will be a substantial spatial imbalance between the supply of recreational boating opportunities and the demand. The demand will exceed the supply over the southern half of the Lower Peninsula. There is a number of possible steps that could be taken to reduce this imbalance. Some of these are as follows:

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[1]This area obviously has the population, income levels, good highway network and fairly readily available boating opportunities necessary to produce a high level of demand.

1. The State could undertake a much greater artificial lake building program in the twenty-eight county region of high demand, concentrating on those suitable sites that are closest to the origins generating the most boating participation.

2. The travel time between the major origin areas and the regions with a surplus of boating opportunities could be reduced. This could be done to a limited extent by improving critical highway linkages. Only a radical change in the time required to reach the regions of high surplus would have a marked effect and this could only be achieved by a revolution in the transportation systems between these origins and the high surplus destinations. Remote possibilities for such a revolutionary change are low fare high volume air travel, monorail trains, or much higher highway speed using a guidance system.

3. Greater use could be made of Great Lakes waters by building a system of breakwaters parallel to the shoreline with harbors of refuge and marinas spaced at about five mile intervals. This would provide a much greater area of water which would be safe for boating through much of the summer season.

All of these possibilities are extremely expensive and appear to be unlikely considering the present financial problems of the State. It is more likely that the supply situation will remain much as it is today and boating participants will adjust to the gradual decline in the number of boating opportunities open to them by boating less, by boating at other than peak periods, by going on boating holidays to surplus regions and by accepting a much higher density of use than is presently considered pleasant.

In Conclusion

This case study of the use of the RECSYS-SYMAP technique to demonstrate the spatial distribution of boating supply, demand, needs, and surplus in 1965 and 1980 has demonstrated that the approach is a valuable geographic tool that should be further developed to obtain even greater reliability and at the same time simplify its application. In particular, it has produced a method for making more precise areal analyses of the major components of recreation systems, namely, origins, destinations, and linkages. It should now be applied to the investigation of other recreational activities in order to provide a wider understanding of the spatial implications of this rapidly growing land use. Studies of this kind can contribute much to our comprehension of the mechanics of the recreational use of resources and add greatly to our knowledge of the recreational geography of an area such as Michigan.

APPENDIX I

A GLOSSARY OF TERMS[1]

Annual Carrying Capacity. The number of user-unit use-periods that a recreation site can provide each year without permanent biological or physical deterioration of the site's ability to support recreation or appreciable impairment of the recreational experience.

BOR. Commonly used abbreviation for Bureau of Outdoor Recreation.

Destination. A general term for the recreation entity or area to which a user goes for recreation. In the RECSYS model individual counties or pairs of counties are the destination units.

MORDS. Commonly used abbreviation for Michigan Outdoor Recreation Demand Study.

Origin. A general term for the place of residence of the recreation user. In the RECSYS model individual counties or pairs of counties are the origin units.

ORRRC. Commonly used abbreviation for Outdoor Recreation Resources Review Commission.

Participation Rate. The number of user-unit use-periods of a particular recreation activity undertaken per capita during a year or some other specified length of time.

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[1]This Glossary is not intended to be exhaustive. It only covers some of the terms that are peculiar to this thesis or that may be unfamiliar to those not well acquainted with outdoor recreation. Some additional useful definitions are contained in Chubb, "Outdoor Recreation Land Capacity: Concepts, Usage and Definitions," cited earlier.

<u>Recreation Entity</u>. An area of land with or without structures which is used for recreation and which is considered as one entity even though it may consist of a number of functional divisions.

<u>RECSYS</u>. The county to county recreation systems modelling computer program for Michigan developed in this study.

<u>Sustained Yield Capacity Standard</u>. The optimum number of user-units per unit area that the recreation site can be designed or managed to accommodate at any one time so that normal patterns of usage will result in the total annual use being close to but not in excess of the annual carrying capacity.

<u>SYMAP</u>. Commonly used abbreviation for the computer mapping technique known as synographic mapping which produces maps on an ordinary line printer.

<u>Use-period.</u> Any period of recreation use that is twenty-four hours or less in duration.

<u>User</u>. A person who obtains a recreation experience from the use of a recreation entity. This term is used to avoid the implication in the word "visitor" that the person has to make some conscious effort to visit a particular distant location.

<u>User-unit</u>. The spatially significant unit by which use is measured. It may be one person, one boat or one automobile.

<u>User-unit Use-period</u>. The unit that is spatially and chronologically significant in determining the allocation of space and time for recreation use. For example, for boating it is a boat use-period signifying the use of a boat for a day or part of a day.

Appendix II. Comparison of 1964 and 1965 Total Estimated Boat Use-Periods at all Michigan Destination Counties by Michigan County of Origin

Origin County		1964 Data		1965 Data				1965
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total	Shift in State-wide % 1964-65	Individual County % Shift from 1964-65	Participation Rate in Boat Use-Periods
401	Baraga	9,390	0.08	22,330	0.14	+.06	+ 137.81	3.44
402	Gogebic	29,240	0.26	70,170	0.45	+.19	+ 139.98	3.15
403	Houghton-Keweenaw	50,040	0.44	60,870	0.39	-.05	+ 21.64	1.76
404	Ontonagon	10,120	0.09	22,930	0.15	+.06	+ 126.58	2.23
405	Dickinson	30,310	0.27	61,470	0.39	+.12	+ 102.80	2.72
406	Iron	77,520	0.68	54.970	0.35	-.33	- 29.09	3.37
407	Menominee	46,040	0.40	41,120	0.26	-.14	- 10.69	1.74
408	Alger	22,320	0.20	8,500	0.05	-.15	- 61.92	.99
409	Delta	31,180	0.27	51,600	0.33	+.06	+ 65.49	1.54
410	Marquette	94,790	0.83	79,710	0.51	-.32	- 15.91	1.36
411	Chippewa	88,150	0.77	91,200	0.58	-.19	+ 3.46	2.75
412	Luce	13,560	0.12	20,430	0.13	+.01	+ 50.66	2.76
413	Mackinac	75,080	0.66	147,600	0.95	+.29	+ 96.59	13.06
414	Schoolcraft	47,930	0.42	49,070	0.31	-.11	+ 2.38	5.71
415	Alpena	86,830	0.76	101,620	0.65	-.11	+ 17.03	3.25
416	Antrim	55,100	0.48	81,550	0.52	+.04	+ 48.00	8.24
417	Charlevoix	44,430	0.39	58,060	0.31	-.02	+ 30.38	4.50
418	Cheboygan	52,970	0.46	130,060	0.83	+.37	+ 145.54	9.03
419	Emmet	61,770	0.54	107,760	0.69	+.15	+ 74.45	7.23
420	Montmorency-Otsego	52,400	0.46	59,190	0.38	-.08	+ 12.96	4.79
421	Presque Isle	35,490	0.31	52,420	0.34	+.03	+ 47.70	3.97
422	Benzie	52,600	0.46	38,360	0.25	-.21	- 27.07	5.18
423	Gr. Trav.-Leelanau	178,460	1.56	288,900	1.85	+.29	+ 61.89	6.55
424	Lake-Mason	57,180	0.50	108,430	0.70	+.20	+ 89.63	4.02
425	Manistee	39,780	0.35	61,190	0.39	+.04	+ 53.82	3.29

Appendix II--Continued

Origin County		1964 Data		1965 Data		Shift in State-wide % 1964-65	Individual County % Shift from 1964-65	1965 Partici-pation Rate in Boat Use-Periods
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total			
426	Newaygo	92,350	0.81	88,500	0.57	-.24	- 4.17	3.58
427	Oceana	19,770	0.17	30,390	0.19	+.02	+ 53.72	1.88
428	Wexford	65,260	0.57	64,520	0.41	-.41	- 1.13	3.65
429	Alcona	24,000	0.21	27,580	0.18	-.03	+ 14.92	4.31
430	Crawford	14,680	0.13	4,660	0.03	-.10	- 68.26	.88
431	Iosco	84,020	0.74	104,240	0.67	-.07	+ 24.07	5.35
432	Kalkas.-Missaukee	15,770	0.14	36,540	0.23	+.09	+ 131.71	3.58
433	Ogemaw-Oscoda[c]	54,110	0.47	45,090	0.29	-.18	- 16.67	3.44
434	Roscommon	56,280	0.49	115,360	0.74	+.25	+ 104.98	14.98
435	Arenac	20,040	0.18	20,550	0.13	-.05	+ 2.54	2.14
436	Bay	136,960	1.12	175,250	1.12	0	+ 27.96	1.54
437	Clare-Gladwin	59,050	0.52	96,800	0.62	+.10	+ 63.93	4.21
438'	Isabella	80,490	0.70	42,290	0.27	-.43	- 47.46	1.12
439	Midland	107,200	0.94	144,880	0.93	-.01	+ 35.15	2.43
440	Mecosta-Osceola	45,650	0.40	112,320	0.72	+.32	+ 146.05	3.27
441	Kent	595,620	5.22	778,990	5.00	-.22	+ 30.79	1.98
442	Ionia-Montcalm	133,240	1.17	209,930	1.35	+.18	+ 57.56	2.58
443	Muskegon	230,390	2.02	289,680	1.86	-.16	+ 25.73	1.81
444	Ottawa	176,270	1.54	267,560	1.72	+.18	+ 51.79	2.43
445	Clinton-Gratiot	93,240	0.82	168,130	1.08	+.26	+ 80.32	2.16
446	Eaton-Ingham[d]	83,880	0.73	498,000	3.19	--	--	1.71
447	Livingstone[e]	399,020	3.49	177,040	1.14	--	--	4.03
448	Saginaw	242,280	2.12	311,660	2.00	-.12	+ 28.64	1.52
449	Shiawassee	78,270	0.69	98,440	0.63	-.06	+ 25.77	1.78
450	Genesee-Lapeer	532,720	4.66	877,050	5.62	+.96	+ 64.64	1.92
451	Huron	22,980	0.20	51,510	0.33	+.13	+ 124.15	1.55
452	St. Clair	185,520	1.62	299,540	1.92	+.30	+ 61.46	2.68
453	Sanilac	22,130	0.19	12,060	0.08	-.11	- 45.50	.38

Appendix II—Continued

Origin County		1964 Data		1965 Data				
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total	Shift in State-wide % 1964-65	Individual County % Shift from 1964-65	1965 Partici-pation Rate in Boat Use-Periods
454	Tuscola	29,930	0.26	58,780	0.38	+.12	+ 96.39	1.32
455	Allegan	115,100	1.01	184,430	1.18	+.17	+ 60.23	3.01
456	Barry	157,270	1.38	166,100	1.07	-.31	+ 5.61	4.94
457	Berrien	246,040	2.15	306,740	1.97	-.18	+ 24.67	1.87
458	Cass-St. Joseph	458,040	4.01	602,180	3.86	-.15	+ 31.47	7.03
459	Kalamazoo	369,560	3.24	470,060	3.01	-.23	+ 27.19	2.48
460	Van Buren	111,940	0.98	214,260	1.37	+.39	+ 91.41	4.13
461	Branch-Calhoun	437,150	3.83	549,600	3.52	-.31	+ 25.72	6.42
462	Hillsdale-Lenawee	245,360	2.15	327,130	2.10	-.05	+ 33.33	2.10
463	Jackson	292,320	2.56	460,080	2.95	+.39	+ 57.39	3.27
464	Monroe	51,640	0.45	184,760	1.18	+.73	+ 257.78	1.64
465	Washtenaw	239,030	2.09	266,470	1.71	-.38	+ 11.48	1.36
466	Macomb	579,050	5.07	822,290	5.27	+.20	+ 42.01	1.55
467	Oakland	1,028,670	9.01	1,318,420	8.46	-.55	+ 28.17	1.63
468	Wayne	2,045,000	17.91	2,642,360	16.95	-.96	+ 29.21	.97
	TOTALS	11,420,070	100.00	15,592,330	99.96	--	+ 36.53	2.45

[a]Michigan State University, Department of Resource Development, Park & Recreation Administration, Michigan Outdoor Recreation Demand Study (Lansing, Michigan: Michigan Department of Commerce, June 1966), original data on boating in 1964 from the "Recreational Boating Survey," 1965.

[b]Michigan Department of Conservation, Waterways Division, original data on boating in 1965 from the "Boating Needs Survey" conducted in 1966.

[c]Some Oscoda data may have been assigned to Monroe and vice-versa in the 1964 study due to a duplicate coding error.

[d]The 1964 data for origin No. 446 do not include Ingham values.

[e]The 1964 data for origin No. 447 includes Ingham values.

Appendix III. Comparison of 1964 and 1965 Total Estimated Boat Use-Periods from All Michigan Counties of Origin at All Michigan Destination Counties

Destination County		1964 Data		1965 Data		Shift in State-wide % 1964-65	Individual County % Shift from 1964-65
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total		
901	Baraga	23,290	0.20	34,120	0.21	+.01	+ 46.50
902	Gogebic	34,490	0.30	80,300	0.50	+.20	+ 196.69
903	Houghton	54,380	0.48	91,260	0.57	+.09	+ 67.82
904	Keweenaw	19,130	0.17	4,090	0.03	-.14	- 73.39
905	Ontonagon	17,250	0.15	20,430	0.13		+ 18.43
906	Dickinson	45,510	0.40	55,860	0.35	-.05	+ 72.74
907	Iron	77,700	0.68	68,740	0.43	-.25	- 11.53
908	Menominee	28,600	0.25	38,660	0.24	-.01	+ 35.17
909	Alger	37,210	0.33	29,470	0.19	-.14	- 20.80
910	Delta	21,470	0.19	54,560	0.34	+.15	+ 154.12
911	Marquette	102,960	0.90	77,460	0.49	-.41	- 24.77
912	Chippewa	129,260	1.13	146,110	0.92	-.21	+ 84.71
913	Luce	58,280	0.51	41,280	0.26	-.25	- 29.17
914	Mackinac	128,210	1.12	194,970	1.22	+.10	+ 52.07
915	Schoolcraft	106,310	0.94	77,290	0.49	-.45	- 27.64
916	Alpena	92,000	0.81	107,070	0.67	-.14	+ 16.38
917	Antrim	142,930	1.25	192,680	1.21	-.04	+ 34.81
918	Charlevoix	94,090	0.82	120,000	0.75	-.07	+ 27.54
919	Cheboygan	268,460	2.35	316,780	1.99	-.36	+ 18.00
920	Emmet	73,460	0.64	130,690	0.82	+.18	+ 77.91
921	Montmorency	90,010	0.79	92,320	0.58	-.21	+ 2.57
922	Otsego	72,420	0.63	118,920	0.75	+.12	+ 64.21
923	Presque Isle	83,960	0.74	105,470	0.66	-.08	+ 25.62
924	Benzie	126,440	1.11	111,180	0.70	-.41	- 12.07
925	Grand Traverse	188,380	1.65	310,010	1.95	+.30	+ 64.57

Appendix III—Continued

Destination County		1964 Data		1965 Data			
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total	Shift in State-wide % 1964-65	Individual County % Shift from 1964-65
926	Leelanau	107,490	0.94	141,500	0.89	-.05	+ 31.64
927	Lake	161,870	1.42	104,060	0.65	-.77	- 35.71
928	Mason	100,560	0.88	114,560	0.72	-.16	+ 13.92
929	Manistee	105,310	0.92	87,730	0.55	-.37	- 16.69
930	Newaygo	261,310	2.29	334,480	2.10	-.19	+ 28.00
931	Oceana	42,250	0.37	92,130	0.58	+.21	+ 118.06
932	Wexford	100,740	0.88	108,310	0.68	-.20	+ 7.51
933	Alcona	142,520	1.25	136,290	0.86	-.39	- 4.37
934	Crawford	46,800	0.41	30,960	0.19	-.21	- 33.85
935	Iosco	312,310	2.73	335,910	2.11	-.62	+ 7.56
936	Kalkas.-Missaukee	63,050	0.55	162,690	1.02	+.47	+ 158.03
937	Ogemaw-Oscoda[c]	153,740	1.35	247,110	1.55	+.20	+ 60,73
938	Roscommon	474,830	4.16	426,120	2.68	-1.48	- 10.26
939	Arenac	62,150	0.54	62,120	0.39	-.15	- 0.05
940	Bay	49,300	0.43	167,840	1.05	+.62	+ 240.45
941	Clare-Gladwin	200,370	1.75	358,270	2.25	+.50	+ 78.80
942	Isabella	13,050	0.11	33,650	0.21	+.10	+ 157.85
943	Midland	28,360	0.25	52,050	0.33	+.08	+ 83.53
944	Mecosta-Osceola	249,710	2.19	247,510	1.55	-.64	- 0.88
945	Kent	187,930	1.65	295,210	1.85	+.20	+ 57.09
946	Ionia-Montcalm	169,150	1.48	295,920	1.86	+.38	+ 74.95
947	Muskegon	168,760	1.48	225,610	1.42	-.06	+ 33.69
948	Ottawa	185,710	1.63	357,830	2.25	+.62	+ 92.68
949	Clinton-Gratiot	5,130	0.04	21,730	0.14	--	+ 323.59
950	Eaton-Ingham[d]	16,440	0.14	57,500	0.36	--	+ 249.76
951	Livingston[e]	307,710	2.69	450,430	2.83	--	+ 46.38
952	Saginaw	13,350	0.12	24,610	0.15	+.03	+ 84.34

Appendix III--Continued

Destination County		1964 Data		1965 Data		Shift in State-wide % 1964-65	Individual County % Shift from 1964-65
No.	Name	Total Boat Use-Periods[a]	% of State-wide Total	Total Boat Use-Periods[b]	% of State-wide Total		
953	Shiawassee	4,190	0.04	8,980	0.06	+.02	+ 114.32
954	Genesee-Lapeer	287,310	2.34	464,500	2.92	+.58	+ 73.77
955	Huron	149,770	1.31	198,080	1.24	-.07	+ 32.26
956	St. Clair	424,830	3.72	698,400	4.39	+.67	+ 64.40
957	Sanilac	27,190	0.24	36,540	0.23	-.01	+ 34.39
958	Tuscola	25,520	0.22	83,300	0.52	+.30	+ 226.41
959	Allegan	145,220	1.27	191,820	1.20	-.07	+ 32.09
960	Barry	337,310	2.95	485,570	3.05	+.10	+ 43.95
961	Berrien	140,200	1.23	190,310	1.20	-.03	+ 35.74
962	Cass-St. Joseph	458,500	4.01	628,980	3.95	-.06	+ 37.18
963	Kalamazoo	195,700	1.71	270,160	1.70	-.01	+ 38.05
964	Van Buren	154,140	1.35	257,880	1.62	+.27	+ 67.30
965	Branch-Calhoun	357,820	3.13	473,460	2.97	-.16	+ 32.32
966	Hillsdale-Lenawee	260,650	2.28	367,870	2.31	+.03	+ 41.14
967	Jackson	315,110	2.76	401,810	2.52	-.24	+ 27.51
968	Monroe[e]	69,200	0.61	194,440	1.22	+.61	+ 180.98
969	Washtenaw	191,470	1.68	325,380	2.04	+.36	+ 69.94
970	Macomb	656,510	5.75	804,890	5.05	-.70	+ 22.60
971	Oakland	662,560	5.80	986,700	6.20	+.40	+ 48.92
972	Wayne	730,180	6.39	931,470	5.85	-.54	+ 27.57
	Dest. Unknown			330,610	2.08	--	--
	TOTAL	11,420,080	100.00	15,923,000	99.99	--	+ 39.43

[a]Michigan State University, Department of Resource Development, Park and Recreation Administration, Michigan Outdoor Recreation Demand Study (Lansing, Michigan: Michigan Department of Commerce, June 1966), original data on boating in 1964 from the "Recreational Boating Survey" made in 1965.

[b]Michigan Department of Conservation, Waterways Division, original data on boating in 1965 from the "Boating Needs Survey" conducted in 1966.

[c]Some Oscoda data may have been assigned to Monroe and vice-versa in the 1964 study due to a duplicate coding error.

[d]The 1964 data for destination No. 950 do not include Ingham values.

[e]The 1964 data for destination No. 951 includes Ingham values.

Appendix IV. List of RECSYS Origin Loading Deck Data for 1965 Boating[a]

Card No.	Origin Code & Area		Boat Use-Periods	Card No.	Origin Code & Area		Boat Use-Periods
1	401	Baraga	22,330	28	424	Lake-Mason	108,430
2	402	Gogebic + 304 Minn.	70,170	29	425	Manistee	61,190
3	403	Houghton-Keweenaw	60,870	30	426	Newaygo	88,500
4	Blank			31	427	Oceana	30,390
5	404	Ontonagon	22,930	32	428	Wexford	64,520
6	405	Dickinson	61,470	33	429	Alcona	27,580
7	406	Iron	54,970	34	430	Crawford	4,660
8	407	Menominee + 306 Wis.	41,120	35	431	Iosco	104,240
9	408	Alger	8,500	36	432	Kalkaska-Missauk.	36,540
10	409	Delta	51,600	37	433	Ogemaw-Oscoda	45,090
11	410	Marquette	79,710	38	434	Roscommon	115,360
12	411	Chippewa	91,200	39	435	Arenac	20,550
13	412	Luce	20,430	40	436	Bay	175,250
14	413	Mackinac	147,600	41	437	Clare-Gladwin	96,800
15	414	Schoolcraft	49,070	42	438	Isabella	42,290
16	415	Alpena	101,620	43	439	Midland	144,880
17	416	Antrim	81,550	44	440	Mecosta-Osceola	112,320
18	417	Charlevoix	58,060	45	441	Kent	778,990
19	418	Cheboygan	130,060	46	442	Ionia-Montcalm	209,930
20	419	Emmet	107,760	47	443	Muskegon	289,680
21	420	Montmor.-Otsego	59,190	48	444	Ottawa	267,560
22	Blank			49	445	Clinton-Gratiot	168,130
23	421	Presque Isle	52,420	50	446	Eaton-Ingham	498,000
24	422	Benzie	38,360	51	447	Livingston	177,640
25	423	Grand Trav.-Leelanau	288,900	52	448	Saginaw	311,660
26	Blank			53	449	Shiawassee	98,440
27	Blank			54	450	Genesee-Lapeer	877,050

Appendix IV--Continued

Card No.	Origin Code & Area	Boat Use-Periods	Card No.	Origin Code & Area	Boat Use-Periods
55	451 Huron	51,510	85	411 Chippewa	91,200
56	452 St. Clair + 307 Ont.	299,540	86	412 Luce	20,430
57	453 Sanilac	12,060	87	413 Mackinac	147,600
58	454 Tuscola	58,780	88	414 Schoolcraft	49,070
59	455 Allegan	184,430	89	415 Alpena	101,620
60	456 Barry	166,100	90	416 Antrim	81,550
61	457 Berrien + 302 Ill.	306,740	91	417 Charlevoix	58,060
	+ 303 Ind.		92	418 Cheboygan	130,060
62	458 Cass-St. Jos.	602,180	93	Blank	
63	459 Kalamazoo	470,060	94	419 Emmet	107,760
64	460 Van Buren	214,260	95	420 Montmorency-Otsego	59,190
65	461 Branch-Calhoun	549,600	96	421 Presque Isle	52,420
66	462 Hillsdale-Lenaw.	327,130	97	422 Benzie	38,360
67	463 Jackson	460,080	98	423 Grand Trav.-Leelanau	288,900
68	464 Monroe + 305 Ohio	184,760	99	424 Lake-Mason	108,430
69	465 Washtenaw	266,470	100	425 Manistee	61,190
70	466 Macomb	822,290	101	426 Newaygo	88,500
71	467 Oakland	1,318,420	102	427 Oceana	30,390
72	468 Wayne	2,642,360	103	428 Wexford	64,520
73	401 Baraga	22,330	104	429 Alcona	27,580
74	402 Gogebic + 304 Minn.	70,170	105	430 Crawford	4,660
75	403 Houghton-Keweenaw	60,870	106	431 Iosco	104,240
76	404 Ontonagon	22,930	107	432 Kalkaska-Missaukee	36,540
77	405 Dickinson	61,470	108	433 Ogemaw-Oscoda	45,090
78	406 Iron	54,970	109	434 Roscommon	115,360
79	407 Menominee + 306 Wis.	41,120	110	435 Arenac	20,550
80	Blank		111	436 Bay	175,250
81	408 Alger	8,500	112	437 Clare-Gladwin	96,800
82	409 Delta	51,600	113	438 Isabella	42,290
83	410 Marquette	79,710	114	Blank	
84	411 Chippewa	91,200	115	439 Midland	144,880

Appendix IV—Continued

Card No.	Origin Code & Area		Boat Use-Periods	Card No.	Origin Code & Area		Boat Use-Periods
116	440	Mecosta-Osceola	112,320	131	455	Allegan	184,430
117	441	Kent	778,990	132	456	Barry	166,100
118	442	Ionia-Montcalm	209,930	133	457	Berrien + 303 Ind.	306,740
119	443	Muskegon	289,680	134	302	Illinois	0
120	444	Ottawa	267,560	135	458	Cass-St. Joseph	602,180
121	445	Clinton-Gratiot	168,130	136	459	Kalamazoo	470,060
122	446	Eaton-Ingham	498,000	137	460	Van Buren	214,260
123	447	Livingston	177,640	138	461	Branch-Calhoun	549,600
124	448	Saginaw	311,660	139	462	Hillsdale-Lenawee	327,130
125	449	Shiawassee	98,440	140	463	Jackson	460,080
126	450	Genesee-Lapeer	877,050	141	464	Monroe + 305 Ohio	184,760
127	451	Huron	51,510	142	465	Washtenaw	266,470
128	452	St. Clair + 307 Ont.	299,540	143	466	Macomb	822,290
129	453	Sanilac	12,060	144	467	Oakland	1,318,420
130	454	Tuscola	58,780	145	468	Wayne	2,642,360

[a]Data Source - Michigan Department of Conservation, Waterways Division, 1965 Recreational Boating Survey. Includes only participation by boaters from Michigan origins.

Appendix V. List of RECSYS Base Utilization Deck Data for 1965 Boating[a]

Card No.	Dest. Code	County	Boat Use-Periods	Card No.	Dest. Code	County	Boat Use-Periods
1	901	Baraga	34,120	31	931	Oceana	92,130
2	902	Gogebic	80,300	32	932	Wexford	108,310
3	903	Houghton	91,260	33	933	Alcona	136,290
4	904	Keweenaw	4,090	34	934	Crawford	30,960
5	905	Ontonagon	20,430	35	935	Iosco	335,910
6	906	Dickinson	55,860	36	936	Kalkaska Missaukee	162,690
7	907	Iron	68,740	37	937	Ogemaw-Oscoda	247,110
8	908	Menominee	38,660	38	938	Roscommon	426,120
9	909	Alger	29,470	39	939	Arenac	62,120
10	910	Delta	54,560	40	940	Bay	167,840
11	911	Marquette	77,460	41	941	Clare Gladwin	358,270
12	912	Chippewa	146,110	42	942	Isabella	33,650
13	913	Luce	41,280	43	943	Midland	52,050
14	914	Mackinac	194,970	44	944	Mecosta Osceola	247,510
15	915	Schoolcraft	77,290	45	945	Kent	295,210
16	916	Alpena	107,070	46	946	Ionia Montcalm	295,920
17	917	Antrim	192,680	47	947	Muskegon	225,610
18	918	Charlevoix	120,000	48	948	Ottawa	357,830
19	919	Cheboygan	316,780	49	949	Clinton Gratiot	21,730
20	920	Emmet	130,690	50	950	Eaton Ingham	57,500
21	921	Montmorency	92,320	51	951	Livingston	450,430
22	922	Otsego	118,920	52	952	Saginaw	24,610
23	923	Presque Isle	105,470	53	953	Shiawassee	8,980
24	924	Benzie	111,180				
25	925	Grand Traverse	310,010				
26	926	Leelanau	141,500				
27	927	Lake	104,060				
28	928	Mason	114,560				
29	929	Manistee	87,730				
30	930	Newaygo	334,480				

Appendix V--Continued

Card No.	Dest. Code	County	Boat Use-Periods	Card No.	Dest. Code	County	Boat Use-Periods
54	954	Genesee Lapeer	464,500	64	964	Van Buren	257,880
55	955	Huron	198,080	65	965	Branch Calhoun	473,460
56	956	St. Clair	698,400	66	966	Hillsdale Lenawee	367,870
57	957	Sanilac	36,540				
58	958	Tuscola	83,300	67	967	Jackson	401,810
59	959	Allegan	191,820	68	968	Monroe	194,440
60	960	Barry	485,570	69	969	Washtenaw	325,380
61	961	Berrien	190,310	70	970	Macomb	804,890
62	962	Cass St. Joseph	628,980	71	971	Oakland	986,700
				72	972	Wayne	931,470
63	963	Kalamazoo	270,160				

[a]Source - Michigan Department of Conservation, Waterways Division, 1965 Recreational Boating Survey. Does not include any estimated use from out-of-state origins.

Appendix VI. List of Values Added to Origin Loading Deck to Simulate 1965 Non-Resident Boating in Michigan

Origin	Assigned Percentage[a]	Boat Use-Periods[b]
Minnesota	.25	31,440
Wisconsin	1.10	171,515
Ontario	.25	31,440
Illinois	1.80	280,661
Ohio	5.80	904,353
Indiana	4.50	701,654
	13.70	2,121,053

[a]Out-of-state boating was assumed to be equal to 13.7 percent of boating by in-state registered boats in the proportions shown.

[b]The estimates of boat use-periods for each out-of-state origin were obtained by multiplying the total in-state use by the assigned percentage.

Appendix VII. Calculation of Destination Capacity in Boat Use-Periods Per Year (All Values in Thousands)[a]

Dest. No.	County	Inland Lakes		Gt. Lks. Zone A		Gt. Lks. Zone B		Gt. Lks. Zone C		Total Boat Use-Periods
		Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	
901	Baraga	8.2	590.4	5.4	291.6	59.1	1,182.0	29.5	14.8	2,078.0
902	Gogebic	37.6	2,707.2	--	--	25.3	506.0	25.3	12.7	3,225.9
903	Houghton	22.9	1,648.8	.3	16.2	42.8	856.0	42.8	21.4	2,542.4
904	Keweenaw	5.4	360.8	1.2	64.8	83.6	1,672.0	81.7	40.9	2,137.5
905	Ontonagon	10.1	727.2	--	--	46.2	924.0	46.2	23.1	1,674.3
906	Dickinson	6.3	453.6	--	--	--	--	--	--	453.6
907	Iron	24.6	1,771.2	--	--	--	--	--	--	1,771.2
908	Menominee	4.5	324.0	1.1	59.4	47.9	958.0	47.9	24.0	1,365.4
909	Alger	12.3	885.6	6.8	367.2	101.2	2,024.0	71.2	25.6	3,302.4
910	Delta	4.4	316.8	12.0	648.0	126.5	2,530.0	74.0	27.0	3,521.8
911	Marquette	27.5	1,980.0	1.9	102.6	100.6	2,012.0	100.6	50.3	4,144.9
912	Chippewa	11.2	806.4	51.7	2,791.8	219.9	4,398.0	139.0	69.5	8,065.7
913	Luce	10.3	741.6	--	--	45.2	904.0	44.0	22.0	1,667.6
914	Mackinac	28.5	2,052.0	2.1	113.4	177.2	3,544.0	128.6	64.3	5,773.7
915	Schoolcraft	27.5	1,980.0	--	--	60.4	1,208.0	44.4	22.2	3,210.2
916	Alpena	17.3	1,245.6	1.8	97.2	80.5	1,610.0	43.5	21.8	2,974.6
917	Antrim	30.1	2,167.2	--	--	30.2	604.0	10.2	5.1	2,776.3
918	Charlevoix	25.0	1,800.0	.7	37.8	119.0	2,380.0	80.0	40.0	5,257.8
919	Cheboygan	51.9	3,736.8	1.4	75.6	76.8	1,536.0	37.0	18.5	5,366.9
920	Emmet	8.0	576.0	.8	43.2	48.6	972.0	77.1	38.6	1,629.8
921	Montmorency	11.5	828.0	--	--	--	--	--	--	828.0
922	Otsego	6.7	482.4	--	--	--	--	--	--	482.4
923	Presque Isle	14.0	1,008.0	1.2	64.8	84.0	1,680.0	78.0	39.0	1,008.0
924	Benzie	17.6	1,267.2	1.3	70.2	35.5	710.0	35.0	17.5	2,064.9
925	Gd. Traverse	13.9	1,000.8	.5	27.0	50.6	1,012.0	--	--	2,039.8
926	Leelanau	17.4	1,252.8	6.6	356.4	100.1	2,002.0	84.6	42.3	3,653.5
927	Lake	4.3	309.6	--	--	--	--	--	--	309.6
928	Mason	9.0	648.0	.1	5.4	40.0	800.0	39.0	19.5	1,472.9

Appendix VII—Continued

Dest. No.	County	Inland Lakes		Gt. Lks. Zone A		Gt. Lks. Zone B		Gt. Lks. Zone C		Total Boat Use-Periods
		Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	
929	Manistee	7.6	547.2	--	--	36.5	730.0	35.6	17.8	1,295.0
930	Newaygo	11.5	828.0	--	--	--	--	--	--	828.0
931	Oceana	3.7	266.4	--	--	37.0	740.0	36.5	18.8	1,025.2
932	Wexford	6.5	468.0	--	--	--	--	--	--	468.0
933	Alcona	12.8	921.6	--	--	37.0	740.0	36.5	18.3	1,679.9
934	Crawford	2.5	180.0	--	--	--	--	--	--	180.0
935	Iosco	10.7	770.4	.6	32.4	48.5	890.0	42.0	21.0	1,713.8
936	Kalkaska	5.3	576.0	--	--	--	--	--	--	892.0
	Missaukee	4.4	316.8	--	--	--	--	--	--	
937	Ogemaw	5.8	417.6	--	--	--	--	--	--	833.6
	Oscoda	5.3	396.0	--	--	--	--	--	--	
938	Roscommon	39.1	2,815.2	--	--	--	--	--	--	2,815.2
939	Arenac	.2	14.4	--	--	48.8	976.0	40.7	20.4	1,010.8
940	Bay	.2	14.4	20.0	1,080.0	36.7	734.0	27.6	13.8	1,842.2
941	Clare	5.2	374.4	--	--	--	--	--	--	871.2
	Gladwin	6.9	496.8	--	--	--	--	--	--	
942	Isabella	1.1	79.2	--	--	--	--	--	--	79.2
943	Midland	2.5	180.0	--	--	--	--	--	--	180.0
944	Mecosta	8.5	612.0	--	--	--	--	--	--	799.2
	Osceola	2.6	187.2	--	--	--	--	--	--	
945	Kent	8.0	576.0	--	--	--	--	--	--	576.0
946	Ionia	1.8	129.6	--	--	--	--	--	--	648.0
	Montcalm	7.2	518.4	--	--	--	--	--	--	
947	Muskegon	10.7	770.4	--	--	38.5	770.0	38.0	19.0	1,559.4
948	Ottawa	5.1	367.2	--	--	35.5	710.0	35.0	17.5	1,094.7
949	Clinton	.8	57.6	--	--	--	--	--	--	158.4
	Gratiot	1.4	100.8	--	--	--	--	--	--	
950	Eaton	.7	50.4	--	--	--	--	--	--	108.0
	Ingham	.8	57.6	--	--	--	--	--	--	
951	Livingston	9.2	662.4	--	--	--	--	--	--	662.4

Appendix VII—Continued

Dest. No.	County	Inland Lakes		Gt. Lks. Zone A		Gt. Lks. Zone B		Gt. Lks. Zone C		Total Boat Use Periods
		Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	Acres	Boat U-P	
952	Saginaw	1.4	100.8	--	--	--	--	--	--	100.8
953	Shiawassee	.9	64.8	--	--	--	--	--	--	64.8
954	Genesee	4.3	309.6	--	--	--	--	--	--	698.4
	Lapeer	5.4	388.8	--	--	--	--	--	--	
955	Huron	.2	14.4	13.9	750.6	116.2	2,124.0	107.2	53.6	2,942.6
956	St. Clair	.6	43.2	34.7	1,873.8	27.1	542.0	34.1	17.1	2,476.1
957	Sanilac	.1	7.2	--	--	53.0	1,060.0	52.0	26.0	1,093.2
958	Tuscola	1.4	100.8	2.1	113.4	20.8	416.0	14.0	7.0	637.2
959	Allegan	7.8	561.6	--	--	35.5	710.0	35.0	17.5	1,289.1
960	Barry	10.4	748.8	--	--	--	--	--	--	748.8
961	Berrien	2.8	201.6	--	--	60.5	1,210.0	59.0	29.5	1,441.1
962	Cass	9.5	684.0	--	--	--	--	--	--	1,339.2
	St. Joseph	9.1	655.2	--	--	--	--	--	--	
963	Kalamazoo	9.7	698.4	--	--	--	--	--	--	698.4
964	Van Buren	6.0	432.0	--	--	19.0	380.0	18.5	9.3	821.3
965	Branch	8.1	583.2	--	--	--	--	--	--	921.6
	Calhoun	4.7	338.4	--	--	--	--	--	--	
966	Hillsdale	3.9	290.8	--	--	--	--	--	--	686.8
	Lenawee	5.5	396.0	--	--	--	--	--	--	
967	Jackson	9.8	705.6	--	--	--	--	--	--	705.6
968	Monroe	.3	21.6	2.4	129.6	45.8	916.0	46.6	23.3	1,090.5
969	Washtenaw	8.9	640.8	--	--	--	--	--	--	640.8
970	Macomb	1.3	93.6	13.3	718.2	13.4	268.0	11.1	5.6	1,085.4
971	Oakland	23.0	1,656.0	--	--	--	--	--	--	1,656.0
972	Wayne	2.6	576.0	16.2	874.8	18.4	368.0	13.1	6.6	1,825.4
	TOTALS	793.8	57,733.2	200.1	10,805.4	2,529.4	50,308.0	2,042.1	1,002.2	119,082.4

[a]All values (acres and boat use-periods) are in thousands.

Appendix VIII. Destination Attraction Deck Data for Boating, 1965 and 1980

		1965 Initial Run			1980 Runs	
Dest. Code	County	Attraction Index[a]	Capacity[b]	Revised 1965 Attr. Index	Modified Attr. Index	Modified Capacity[b]
901	Baraga	0.90	2,078.0	0.61	0.61	c
902	Gogebic	1.07	3,225.9	2.40	2.76	c
903	Houghton	1.50	2,542.4	2.79	3.07	c
904	Keweenaw	1.00	2,137.5	0.08	0.08	c
905	Ontonagon	1.05	1,674.3	0.49	0.52	c
906	Dickinson	0.80	453.6	3.65	3.83	c
907	Iron	1.10	1,771.2	1.07	1.23	c
908	Menominee	0.95	1,365.4	0.38	0.40	c
909	Alger	0.82	3,302.4	0.51	0.56	c
910	Delta	1.42	3,521.8	3.82	4.01	c
911	Marquette	1.07	4,144.9	1.18	1.29	c
912	Chippewa	1.15	8,065.7	5.79	6.37	c
913	Luce	0.85	1,667.6	10.49	11.54	c
914	Mackinac	1.05	5,773.7	1.58	1.97	c
915	Schoolcraft	0.09	3,210.2	3.36	3.86	c
916	Alpena	1.05	2,974.6	0.93	1.02	c
917	Antrim	1.35	2,776.3	5.80	6.96	c
918	Charlevoix	1.40	5,257.8	3.55	4.26	c
919	Cheboygan	1.52	5,366.9	4.28	5.14	c
920	Emmet	1.37	1,629.8	11.63	13.96	c
921	Montmorency	0.80	828.0	3.04	3.50	c
922	Otsego	0.62	482.4	6.04	6.64	c
923	Presque Isle	0.90	1,008.0	3.57	4.10	c
924	Benzie	1.00	2,064.9	0.43	.54	c
925	Gr. Traverse	1.40	2,039.8	2.72	3.27	c
926	Leelanau	1.22	3,653.5	2.25	3.02	c
927	Lake	0.80	309.6	0.99	1.09	c

Appendix VIII—Continued

Dest. Code	County	1965 Initial Run: Attraction Index[a]	1965 Initial Run: Capacity[b]	Revised 1965 Attr. Index	1980 Runs: Modified Attr. Index	1980 Runs: Modified Capacity[b]
929	Mason	1.07	1,472.9	0.23	0.25	c
929	Manistee	1.15	1,295.0	0.34	0.39	c
930	Newaygo	0.97	828.0	0.87	1.00	c
931	Oceana	0.60	1,025.2	0.22	0.22	c
932	Wexford	0.90	468.0	1.22	1.40	c
933	Alcona	1.00	1,679.9	1.51	1.81	c
934	Crawford	0.40	180.0	2.02	2.02	c
935	Iosco	1.27	1,713.8	1.38	1.52	c
936	Kalkaska, Missaukee	0.52	892.0	2.67	2.80	c
937	Ogemaw, Osoda	0.50	833.6	3.00	3.45	c
938	Roscommon	1.30	2,815.2	1.65	2.06	c
939	Arenac	0.42	1,010.8	0.20	0.20	c
940	Bay	0.65	1,842.2	0.17	0.17	c
941	Clare, Gladwin	0.85	871.2	1.41	1.55	c
942	Isabella	0.42	79.2	1.07	1.12	122.4
943	Midland	0.35	180.0	0.53	0.58	237.6
944	Mecosta, Osceola	0.55	799.2	0.79	0.95	c
945	Kent	0.62	576.0	0.72	0.83	c
946	Ionia, Montcalm	0.40	648.0	0.67	0.74	698.4
947	Muskegon	1.27	1,559.4	0.25	0.28	c
948	Ottawa	1.47	1,094.7	0.50	0.53	c
949	Clinton, Gratiot	0.33	158.4	0.15	0.20	223.2

Appendix VIII--Continued

Dest. Code	County	1965 Initial Run: Attraction Index[a]	1965 Initial Run: Capacity[b]	Revised 1965 Attr. Index	1980 Runs: Modified Attr. Index	1980 Runs: Modified Capacity[b]
950	Eaton / Ingham	0.35	108.0	0.46	0.58	158.4
951	Livingston	0.80	662.4	0.52	0.62	c
952	Saginaw	0.40	100.8	0.22	0.28	136.8
953	Shiawassee	0.20	64.8	0.12	0.15	108.0
954	Genesee / Lapeer	0.48	698.4	0.58	0.70	712.8
955	Huron	1.10	2,942.6	0.09	0.10	c
956	St. Clair	1.50	2,476.1	0.29	0.32	c
957	Sanilac	0.40	1,093.2	0.03	0.03	c
958	Tuscola	0.40	637.2	0.13	0.13	c
959	Allegan	0.82	1,289.1	0.19	0.21	c
960	Barry	0.70	748.8	0.77	0.92	c
961	Berrien	0.75	1,441.1	0.15	0.17	c
962	Cass / St. Joseph	0.87	1,339.2	0.53	0.64	c
963	Kalamazoo	0.72	698.4	0.39	0.45	c
964	Van Buren	0.60	821.3	0.37	0.43	c
965	Branch / Calhoun	0.60	921.6	0.64	0.77	c
966	Hillsdale / Lenawee	0.50	686.8	0.48	0.53	c
967	Jackson	0.60	705.6	0.49	0.59	c
968	Monroe	0.80	1,090.5	0.11	0.11	c
969	Washtenaw	0.65	640.8	0.43	0.43	c
970	Macomb	1.15	1,085.4	0.59	0.59	c
971	Oakland	0.95	1,656.0	0.49	0.59	c
972	Wayne	0.87	1,825.4	0.40	0.40	c

[a]Initial attempt at boating attraction index.

[b]In thousands of boat use-periods per year.

[c]Same value as for 1965 run.

Appendix IX. List of RECSYS Highway Link Data Assigned for 1965[a] and 1980
(1965 Values on the Left, 1980 on the Right of the Oblique Stroke)

Link No.	Distance (miles)	Speed (m.p.h.)	Toll	Link No.	Distance (miles)	Speed (m.p.h.)	Toll
573	14/14	40/45	--	601	10/10	50/55	--
574	25/25	45/55	--	602	12/12	45/50	--
575	15/15	35/40	--	603	6/6	40/40	--
576	27/27	45/45	--	604	6/6	50/50	--
577	30/30	35/35	--	605	10/10	55/60	--
578	15/15	45/55	--	606	6/6	35/40	--
579	26/26	40/45	--	607	30/30	50/55	--
580	41/41	40/45	--	608	27/27	50/55	--
581	17/41	45/55	--	609	15/15	40/40	--
582	36/36	35/40	--	610	15/13	45/50	--
583	24/24	40/40	--	611	14/14	45/65	--
584	18/18	50/55	--	612	6/6	60/65	--
585	40/40	55/55	--	613	5/5	50/60	--
586	35/35	40/45	--	614	10/10	60/65	--
587	13/13	40/45	--	615	10/10	60/65	--
588	11/11	45/50	--	616	22/22	40/55	--
589	5/5	35/45	--	617	14/14	50/65	--
590	12/12	40/45	--	618	10/10	50/50	--
591	15/15	35/40	--	619	11/11	30/35	--
592	17/17	40/45	--	620	17/17	55/65	--
593	15/15	45/45	--	621	10/10	55/65	--
594	24/24	35/40	--	622	12/12	45/65	--
595	15/13	40/55	--	623	12/12	60/65	--
596	10/10	45/55	--	624	18/18	40/45	--
597	10/10	35/40	--	625	15/15	45/50	--
598	5/5	30/30	--	626	17/17	35/65	--
599	7/7	40/40	--	627	17/17	50/50	--
600	11/11	40/45	--	628	12/12	30/45	--

Appendix IX--Continued

Link No.	Distance (miles)	Speed (m.p.h.)	Toll	Link No.	Distance (miles)	Speed (m.p.h.)	Toll
629	15/15	45/45	--	649	31/31	40/40	--
630	7/7	45/45	--	650	33/33	40/55	--
631	14/14	45/50	--	651	40/40	40/45	--
632	12/12	40/45	--	652	48/48	50/55	--
633	16/16	50/65	--	653	40/40	45/55	--
634	60/60	40/65	1.50/1.50	654	44/44	45/55	--
635	9/9	45/50	--	655	61/61	50/50	--
636	10/10	60/65	--	656	32/32	50/55	--
637	20/20	50/65	--	657	33/33	40/55	--
638	30/30	40/65	--	658	22/22	45/55	--
639	9/9	45/65	--	659	47/47	45/50	--
640	10/10	50/65	--	660	40/40	40/55	--
641	5/5	40/45	--	692	41/41	45/50	--
642	15/15	55/65	--	693	15/15	45/50	--
643	15/15	40/45	--	694	20/20	50/55	--
644	20/20	50/65	--	695	23/23	60/65	--
645	20/20	40/55	--	696	15/15	45/50	--
646	80/80	45/55	--	697	30/27	50/65	--
647	29/29	40/55	--	698	30/36	55/60	--
648	28/28	45/50	--	699	21/21	45/50	--
				700	25/23	50/65	--
					28/28	50/55	--

Appendix X. Percentage Error of Prediction for Sample Runs During Calibration of the RECSYS Model

		Percentage Error of Prediction by Runs					
No.	Destination	Run 1	Run 3	Run 4A	Run 6B	Run 7C	Run 8A
901	Baraga	88.5	75.9	39.1	49.0	40.4	40.5
902	Gogebic	-47.6	-44.9	-33.1	-37.0	-33.1	-35.5
903	Houghton	-51.6	-48.1	-37.7	-40.6	-36.8	-36.2
904	Keweenaw	152.5	167.8	259.2	223.3	167.2	59.2
905	Ontonagon	68.7	68.1	65.0	66.0	59.2	47.4
906	Dickinson	-43.8	-47.8	-62.4	-57.9	-63.1	-57.0
907	Iron	8.8	6.8	-5.8	-1.1	4.6	15.2
908	Menominee	75.8	70.1	47.7	55.0	53.9	71.8
909	Alger	25.1	27.6	36.4	33.6	29.1	13.7
910	Delta	-56.1	-51.6	-28.2	-36.9	-41.7	-56.1
911	Marquette	-22.9	-20.1	-7.9	-12.1	-12.6	-16.6
912	Chippewa	-66.3	-65.0	-56.8	-60.2	-56.2	-57.3
913	Luce	-78.0	-77.4	-73.6	-75.2	-77.9	-80.5
914	Mackinac	-31.0	-30.7	-29.8	-30.2	-26.5	-5.5
915	Schoolcraft	-53.2	-53.7	-53.5	-54.0	-52.2	-48.4
916	Alpena	-11.3	-7.0	15.9	6.0	14.2	1.3
917	Antrim	-75.0	-69.0	-51.6	-58.1	-50.2	-56.7
918	Charlevoix	-56.0	-47.6	-14.2	-28.1	-21.2	-39.8
919	Cheboygan	-27.9	-24.3	-20.1	-21.7	-19.1	-32.3
920	Emmet	-85.7	-84.6	-77.7	-80.4	-81.7	-88.3
921	Montmorency	-55.7	-53.4	-52.5	-54.1	-53.0	-57.2
922	Otsego	-43.7	-71.8	-83.6	-82.7	-83.3	-83.7
923	Presque Isle	-15.5	-23.8	-46.8	-41.1	-47.4	-45.1
924	Benzie	-46.4	-33.8	15.9	-1.9	3.8	-29.6
925	Grand Traverse	-26.1	-27.1	-26.7	-28.1	-26.2	-25.3

Appendix X—Continued

No.	Destination	Percentage Error of Prediction by Runs					
		Run 1	Run 3	Run 4A	Run 6B	Run 7C	Run 8A
926	Leelanau	-70.4	-61.5	-9.5	-30.4	-26.3	-59.0
927	Lake	-35.4	-38.1	-39.4	-39.0	-41.2	-43.0
928	Mason	-40.8	-16.4	71.6	43.6	67.7	25.0
929	Manistee	-28.6	-9.7	60.2	36.4	39.0	-7.3
930	Newaygo	-45.1	-35.1	-26.3	-27.3	-28.4	-35.5
931	Oceana	7.3	4.7	25.0	16.3	16.7	-15.0
932	Wexford	5.0	-11.5	-32.7	-29.6	-32.7	-29.8
933	Alcona	-79.7	-75.9	-48.5	-59.5	-48.1	-64.9
934	Crawford	-28.6	-72.3	-77.4	-77.7	-76.6	-79.4
935	Iosco	-74.3	-71.4	-49.3	-57.0	-44.5	-52.8
936	Kalkaska Missaukee	84.8	-76.3	-71.4	-72.5	-72.3	-76.7
937	Ogemaw Oscoda	-93.0	-90.5	84.0	-85.7	-83.4	-86.5
938	Roscommon	-84.3	-70.8	-29.1	-41.3	-28.0	-47.2
939	Arenac	-46.8	-23.8	11.2	5.1	20.9	18.1
940	Bay	24.3	102.5	108.2	113.0	115.5	133.9
941	Clare Gladwin	-64.0	-39.5	-46.5	-43.6	-43.8	-40.1
942	Isabella	69.2	-36.7	-63.8	-59.5	-65.8	-63.1
943	Midland	315.9	22.1	-47.9	-39.0	-48.2	-34.5
944	Mecosta Osceola	-85.7	-39.8	-36.3	-33.4	-41.3	-45.8
945	Kent	21.3	-1.1	-35.8	-28.5	-34.5	-18.8
946	Ionia Montcalm	-27.6	-18.2	-49.4	-42.4	-46.9	-32.2

Appendix X—Continued

No.	Destination	Run 1	Run 3	Run 4A	Run 6B	Run 7C	Run 8A
		Percentage Error of Prediction by Runs					
947	Muskegon	-43.4	-23.1	59.0	32.6	54.4	29.7
948	Ottawa	-5.8	12.8	44.6	38.2	44.0	25.7
949	Clinton, Gratiot	907.0	290.5	67.9	100.2	80.2	162.3
950	Eaton, Ingham	570.7	34.8	-41.0	-30.6	-39.5	-20.8
951	Livingston	220.6	118.3	12.4	31.3	13.2	34.5
952	Saginaw	963.6	244.6	29.4	57.2	29.7	69.4
953	Shiawassee	2516.2	260.1	30.6	59.2	33.6	82.5
954	Genesee, Lapeer	51.8	8.7	-43.1	-33.7	-41.5	-24.2
955	Huron	-77.8	-31.7	116.4	69.5	90.7	0.6
956	St. Clair	-82.1	-55.2	25.0	2.3	20.7	-5.2
957	Sanilac	113.1	281.5	357.8	356.8	326.0	239.9
958	Tuscola	143.7	165.7	65.7	86.0	62.8	88.6
959	Allegan	76.1	118.4	139.9	139.9	137.6	129.7
960	Barry	1.7	-1.4	-32.3	-25.2	-32.9	-24.1
961	Berrien	-20.0	28.4	119.9	100.8	119.9	88.6
962	Cass, St. Joseph	-12.8	-1.6	2.6	3.9	6.3	11.9
963	Kalamazoo	216.6	132.3	36.9	54.4	37.9	69.1
964	Van Buren	20.4	4.7	-6.4	-4.3	-6.7	-5.2
965	Branch, Calhoun	-73.5	-46.8	-29.6	-29.8	-36.7	-48.3
966	Hillsdale, Lenawee	16.8	8.7	-22.0	-14.1	-20.7	-9.6
967	Jackson	-31.2	-2.6	-15.8	-9.3	-12.8	-0.5

Appendix X--Continued

No.	Destination	Run 1	Run 3	Run 4A	Run 6B	Run 7C	Run 8A
		Percentage Error of Prediction by Runs					
968	Monroe	336.9	350.3	285.9	313.9	283.1	266.1
969	Washtenaw	-64.7	6.5	1.4	8.2	5.1	18.8
970	Macomb	42.9	31.2	-3.0	5.5	6.0	40.9
971	Oakland	8.6	31.2	20.6	28.3	24.9	35.8
972	Wayne	-0.0	18.5	26.8	29.8	27.8	33.4
Dest. Attr. Scaling Const.		1.6539	.016539	.002066	.003308	.003308	.003308
Highway Link Resist. Const.		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Highway Link Cost Weight		0.0000	0.0000	0.0000	0.0000	0.0000	0.5000
Highway Link Time-Cost Comp.		1.5000	1.5000	1.5000	1.5000	2.0000	2.5000
Std. Deviation of Pred.		352.5	95.0	80.2	79.9	74.3	69.0

Appendix XI. Calculation of Assumed 1980 Boating Participation Rates and Loading Value for Each Origin

No.	Origin	1965 Rate[a]	Ratio to 1965 Av. Rate[b]	1980 Rate[c]	P 1980 Population[d]	1980 Boat Use-Periods[e]
401	Baraga	3.44	1.40	8.27	7,501	62,033
402	Gogebic	3.15	1.29	7.62	17,368	132,344
	Minnesota	0.01	0.004	0.02	4,060,934	81,219
403	Hough.-Keweenaw	1.76	0.72	4.26	35,331	150,510
404	Ontonagon	2.23	0.91	5.38	11,841	63,705
405	Dickinson	2.72	1.11	6.56	22,892	150,172
406	Iron	3.37	1.38	8.16	17,466	142,523
407	Menominee	1.74	0.71	4.20	25,064	105,269
	Wisconsin	0.04	0.02	0.12	5,404,667	648,560
408	Alger	0.99	0.40	2.36	7,697	18,165
409	Delta	1.54	0.63	3.72	34,046	126,651
410	Marquette	1.36	0.56	3.31	81,216	268,825
411	Chippewa	2.75	1.12	6.62	37,291	246,866
412	Luce	2.76	1.13	6.68	6,911	46,165
413	Mackinac	13.06	5.33	31.50	10,658	335,727
414	Schoolcraft	5.71	2.33	13.77	7,303	100,562
415	Alpena	3.25	1.33	7.86	32,564	255,953
416	Antrim	8.24	3.36	19.86	10,460	207,736
417	Charlevoix	4.50	1.84	10.87	14,997	163,017
418	Cheboygan	9.03	3.69	21.81	13,519	294,849
419	Emmet	7.23	2.95	17.43	17,073	297,582
420	Mont.-Otsego	4.79	1.96	11.58	14,219	164,656
421	Presque Isle	3.97	1.62	9.57	14,012	134,095
422	Benzie	5.18	2.11	12.47	7,507	93,612
423	Grand Traverse-Lee.	6.55	2.67	15.78	52,896	834,699
424	Lake-Mason	4.02	1.64	9.69	28,125	272,531
425	Manistee	3.29	1.34	7.92	20,327	160,990

Appendix XI--Continued

No.	Origin	1965 Rate[a]	Ratio to 1965 Av. Rate[b]	1980 Rate[c]	1980 Population[d]	1980 Boat Use-Periods[e]
426	Newaygo	3.58	1.46	8.63	27,927	241,010
427	Oceana	1.88	0.77	4.55	16,086	73,191
428	Wexford	3.65	1.49	8.81	19,145	168,667
429	Alcona	4.31	1.76	10.40	6,019	62,598
430	Crawford	.88	0.36	2.13	6,020	12,823
431	Iosco	5.35	2.18	12.88	34,639	446,150
432	Kalk.-Missaukee	3.58	1.46	8.63	10,658	91,979
433	Ogemaw-Oscoda	3.44	1.40	8.27	12,731	105,528
434	Roscommon	14.98	6.11	36.11	8,784	317,190
435	Arenac	2.14	0.87	5.14	9,968	51,236
436	Bay	1.54	0.63	3.72	117,330	436,468
437	Clare-Gladwin	4.21	1.72	10.17	24,769	251,901
438	Isabella	1.12	0.46	2.72	40,544	110,280
439	Midland	2.43	0.99	5.85	71,345	417,368
440	Mecosta-Osceola	3.27	1.33	7.86	39,377	309,503
441	Kent	1.98	0.81	4.79	459,453	2,200,780
442	Ionia-Montcalm	2.58	1.05	6.21	92,265	572,966
443	Muskegon	1.81	0.74	4.37	171,506	749,481
444	Ottawa	2.43	0.99	5.85	139,929	818,585
445	Clinton-Gratiot	2.16	0.88	5.20	98,482	512,106
446	Eaton-Ingham	1.71	0.70	4.14	365,611	1,513,630
447	Livingston	4.03	1.64	9.69	54,075	523,987
448	Saginaw	1.52	0.62	3.66	245,221	897,509
449	Shiawassee	1.78	0.73	4.31	65,033	280,292
450	Gen.-Lapeer	1.92	0.78	4.61	605,106	2,789,539
451	Huron	1.55	0.63	3.72	35,920	133,622
452	St. Clair	2.68	1.09	6.44	117,134	754,343
	Ontario	0.00455	0.002	0.01	9,394,880	93,949
453	Sanilac	.38	0.16	0.95	36,610	34,780
454	Tuscola	1.32	0.54	3.19	49,046	156,457
455	Allegan	3.01	1.23	7.27	65,721	477,792

Appendix XI--Continued

No.	Origin	1965 Rate[a]	Ratio to 1965 Av. Rate[b]	1980 Rate[c]	1980 Population[d]	1980 Boat Use-Periods[e]
456	Barry	4.94	2.02	11.94	30,487	364,015
457	Berrien	1.87	0.76	4.49	191,539	860,010
	Illinois	0.03	0.01	0.06	12,818,940	769,136
	Indiana	0.14	0.16	0.35	5,754,907	2,014,217
458	Cass-St. Joseph	7.03	2.87	16.96	95,029	1,611,692
459	Kalamazoo	2.48	1.01	5.97	222,128	1,326,104
460	Van Buren	4.13	1.69	9.99	60,293	602,327
461	Branch-Calhoun	6.42	2.62	15.48	188,648	2,920,271
462	Hillsdale-Lenawee	2.10	0.86	5.08	116,643	592,546
463	Jackson	3.27	1.33	7.86	144,146	1,132,988
464	Monroe	1.64	0.67	3.96	132,826	525,991
	Ohio	0.09	0.04	0.24	13,269,932	3,184,784
465	Washtenaw	1.36	0.56	3.31	300,382	994,264
466	Macomb	1.55	0.63	3.72	954,332	3,550,115
467	Oakland	1.63	0.67	3.96	1,136,365	4,500,005
468	Wayne	.97	0.40	2.36	2,700,499	6,373,178
	Average	2.45		TOTALS	60,572,315	52,486,368

[a]1965 participation rate in boat use-periods per capita per year is observed value shown in Appendix II.

[b]The ratio in column two was obtained by dividing the value in column one by the statewide average of 2.45.

[c]The 1980 participation rate was calculated by multiplying the ratio in column two by the assumed 1980 statewide participation rate of 5.91 boat use-periods per capita per year.

[d]Source: David Goldberg and Allan Schnaiberg, Michigan Population 1960 and 1980 (Lansing, Michigan: State Resource Planning Program, Michigan Department of Commerce, January 1966), working Paper No. 2, pp. 19-103. Out-of-state origins from correspondence with various state planning officials and projections based on Bureau of the Census data.

[e]Column five was calculated by multiplying column four by column three.

Appendix XII. Some Comments on the Performance of SYMAP and on the Future Development and Application of RECSYS

Performance of the Computer Mapping Technique

As the illustrations in Chapters III and IV have demonstrated, the SYMAP technique of producing maps is a very significant adjunct to the RECSYS method of simulating recreation demand. The researcher only has to transfer the RECSYS output to a deck of eighty-five data processing cards and submit these new cards along with the rest of the SYMAP program which is not changed. Once the program is actually fed into the computer, the isopleth map and the choropleth map together with the calculations necessary to determine the shading level to be assigned to each node are completed in about two minutes. If the researcher is able to obtain rapid card punching service or can punch his own data processing cards, he can take the output from the RECSYS program (which takes approximately four minutes computer running time), prepare the SYMAP data deck and submit the SYMAP program all within about half an hour. Since normally the recreation planner requires maps of demand, supply, needs, and surplus

the best method is to have four SYMAP programs set up. Four SYMAP data decks can then be prepared and the programs for the four separate phenomena submitted simultaneously.

If reasonably good computer service is available, it is possible for a researcher to go completely through a RECSYS program run and then produce the eight SYMAP graphic representations of the output data all in a single day. Without the SYMAP program, it would probably be necessary to wait many days, perhaps weeks, until the calculations had been made and the maps drafted. Obviously the researcher who uses the SYMAP program obtains a visual impression of the situation much sooner than if he had to wait for manual drafting. This can quite be significant especially if he is asked to prepare a report on a special proposal and present it at a forthcoming staff meeting.

Time can also be important where documents such as statewide recreation plans have to be brought up-to-date at frequent intervals. If only limited drafting facilities are available, the preparation of illustrative maps for such a plan could take several months if some ten or twelve activities have to be analysed separately. SYMAP would be of particular value in such cases. Possibly many reports could use reductions of copy photographs of the SYMAP print-outs exactly as they come from the computer printer without mount-ing or the addition of any lettering except a typed caption which would be added after production of the plate or stencil. In such cases, it is conceivable that the entire RECSYS-SYMAP process and the reproduction and printing of multiple copies of the maps could take place in one day.

It will be seen from the illustrations in the preceeding Chapters that the SYMAP technique can produce very acceptable maps. A discussion of the accuracy of the choropleth maps is beyond the scope of this thesis but it is clear that accuracy could be improved by the use of more numerous smaller areal units and hence more frequent nodes. The possibility of using townships as origins and destinations will be discussed in the next section.

One technical problem in connection with the production of SYMAP should be pointed out. It will be seen from Figure 5 that differences in the darkness of the symbols produced by the computer printer due to the amount of use received by the ribbon can cause considerable variation in the reproduction of the same level of shading between the two halves of the map. This problem can be eliminated if the computer operator is alerted to the fact that the two halves of the map must be printed uniformly so they can be joined. It will be seen that the problem has been avoided in most of the other choropleth maps and in some cases it is not possible to detect where the join was made. This was done by carefully selecting the lines along which the join would be made so that the contours continued in a natural manner and the degree of darkness of the symbols both sides of the junction was reasonably equal.

Future Development of the Technique

It should be clearly understood that the attempt to use the RECSYS-SYMAP technique as a planning tool described in this thesis is a preliminary demonstration and test of the method and cannot be considered a perfect example of the use of this technique. As is the case with any new device, it can be greatly improved by repeated use and refinement of all its component parts and procedures. The intensive refinement of one aspect of the technique will not result in an equivalent overall improvement. Each component must receive attention if the entire process is to be substantially improved.

As indicated earlier, the lack of adequate recreation use data by origin and destination is perhaps the greatest problem at present. Refinement of the model itself is not warranted until this problem is solved. A number of data difficulties in connection with boating have been described in Chapters II. Similar problems exist in the case of other recreation activities. In many instances, information on the amount of use occuring at commercial and private recreation entities is entirely lacking. Data on use by out-of-state residents are also often absent. A concerted program of data gathering both in the form of periodic statewide home surveys and regular destination use studies is needed to provide a sound basis for recreation planning whether the RECSYS-SYMAP approach or some other technique is used.[1]

A by-product of regular use studies would be data on the growth trends in recreation. Such data are needed in order to more accurately predict future participation rates. The problems created by the present lack of adequate trend information is indicated by the difficulties encountered in projecting the probable participation in boating by 1980 as described in Chapter IV.

Investigation of the various facets of the supply information used in the RECSYS simulation is also needed. A coordinated program of recreation resource inventories and user preference studies is needed in order to produce the necessary data on recreation capacity and attraction indices.

If progress can be made towards the development of better information on recreation supply and demand then further refinement of the RECSYS-SYMAP technique will be warranted.

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[1]Suggestions on the structure of such a program are contained in the author's report to the Michigan Department of Conservation.

The first logical step in this direction would appear to be the reduction of the size of the origin and destination spatial units. This would not be accomplished easily. If the entire model was changed to using townships instead of counties, the program would become much longer and require extensive use of memory tapes. It would also be necessary to have use data by township of origin and township of destination. This would require a very advanced and complicated data gathering system which is hard to envisage at present when even information on a county to county basis is lacking. It is, therefore, probably more realistic to suggest that an intermediate step would be best in which origin counties with high demand and destination counties with high use would be treated on a township basis.

If part of the model was based on the township as a spatial unit, the accuracy of the SYMAP representations would be improved in the regions so divided. Nodes would be closer together and demand and supply phenomena would be represented more precisely. However, it is doubtful if the modification of the SYMAP program to give a triple width map would be warranted until a major part of the state or all of it was being treated on a township by township basis. It should be recognized that the mdofication of RECSYS-SYMAP to the use of spatial units smaller than counties would not only result in data gathering problems but also cause the entire process to be much slower and more costly. Indeed, the much greater time needed for the production of the input data would to some extent eliminate the advantage of obtaining results rapidly cited earlier.

Further Applications of the RECSYS-SYMAP Approach

Discussion of the possible uses of the RECSYS-SYMAP approach in recreation planning could occupy another complete thesis of this length. Ellis has already suggested some possible applications of the technique as a planning tool and for various recreation research problems.[1] It should be pointed out, however, that the technique could also be used for recreation planning and research involving areas other than single states. With appropriate modifications, the approach could be employed in nationwide recreation planning such as is now being attempted by the Bureau of Outdoor Recreation in the Department of the Interior. Regional recreation planning covering five or six states like the planning being done by the Bureau in the case of a number of major watersheds is also quite feasible. Again with suitable modification, the approach could be used for regions within states such as the areas in Michigan

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[1]Ellis, Outdoor Recreation Planning in Michigan by a Systems Analysis Approach, Part I, op.cit., pp. 51-61.

covered by the Detroit Metropolitan Regional Planning Commission or the Tri-County Planning Commission in Ingham, Eaton and Clinton Counties. On an even smaller scale, the technique has potential for planning the recreational facilities of a city or for deciding on the scale and type of development at an individual recreation entity.

Prospects for the successful use of RECSYS-SYMAP in such situations are bright if planners, geographers, and other research workers remember that the reliability of the method depends on the reliability of the data used. With good information on supply and demand, there is no presently known technique which is able to predict the probable future spatial distribution of recreation supply, demand, surplus, and needs with equivalent assurance that the predictions are likely to closely approximate the actual distribution under the given conditions.

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