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AN ASSESSMENT OF TEMPORAL AND SPATIAL CHANGES AND NEEDS FOR MARINA MOORINGS SERVING MICHIGAN'S GREAT LAKES

Michigan State University PH.D. 1987

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AN ASSESSMENT OF TEMPORAL AND SPATIAL CHANGES AND NEEDS FOR MARINA MOORINGS SERVING MICHIGAN'S GREAT LAKES

By

Gene Leroy Brothers

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Park and Recreation Resources

1987

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AN ABSTRACT OF A DISSERTATION

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ABSTRACT

AN ASSESSMENT OF TEMPORAL AND SPATIAL CHANGES AND NEEDS FOR MARINA MOORINGS SERVING MICHIGAN'S GREAT LAKES

By

Gene Leroy Brothers

There were two major purposes for this study. The first was to provide information which would be useful in directing future development of marinas serving Michigan's Great Lakes. The second was to examine the applicability of selected measures of needs for marina moorings. Three objectives of the study were: to inventory Michigan marinas serving the Great Lakes during 1983, determine trends in marina development from 1978 to 1983, and develop and evaluate marina needs indices. Marina data for this analysis were collected from aerial photographs taken during 1978 and 1983. The data used for measuring mooring needs were: population, boat registrations, and origin/destination data for Michigan Great Lakes boating use.

A significant finding was that there were 41,496 moorings serving Michigan's Great Lakes during the 1983 boating season. The majority (79%) of these moorings are concentrated in the southern one third of the state. Over the five year study period mooring capacity increased by 16.39%. Marinas serving Lake Erie provided 35% more moorings over the five years.

Assessment of needs based on five needs indices yielded mixed results. None of the indices was totally satisfactory and a proposed ideal index could not be developed because of data limitations. Experiences gained should be helpful in future marina needs assessments.

To Jared and Nathan, who
made this dissertation nearly impossible.

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Most sincerely, to my wife, Marcie, I owe a debt I can never repay. A dissertation and two babies are beyond the threshold of a reasonable life and I ask her forgiveness. It has been only through her determination, financial support, and love that this dissertation has reached its conclusion.

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CHAPTER I

INTRODUCTION

Michigan's Great Lakes provide an array of recreational opportunities. In the past decade, improved water quality and fisheries have contributed to a surge in interest and use of these lakes for a variety of recreational activities. Great Lakes recreational boating, in particular, has increased steadily in recent years. A comparison of studies conducted to document boating activity in Michigan indicates Great Lakes boating in Michigan grew by 28 percent from 1977 to 1980 (Stynes and Holecek, 1982:17; Stynes and Safronoff, 1982:80). Along with more in Great Lakes boating activity, number of access sites to service boaters has also grown. This increase is demonstrated by the steady growth in number of applications to the Land Resource Programs Division, Michigan Department of Natural Resources (MDNR) for marina construction permits and for permits to operate marinas which has occurred in recent years (Feldhauser, 1983).

It has been suggested in previous studies that demand for moorings in specific areas of the Great Lakes is greater than supply, and "public agencies as well as private enterprises are stimulated to construct recreational harbors and related facilities at an accelerated rate in an attempt to meet what they perceive to be a rapidly increasing need" (Han, 1975:4). In a study of commercial marina owners on Ohio's Lake Erie shoreline, McKinney (1979:38) showed that location was an important

factor influencing growth and development decisions. Owners interviewed felt that a prime location was a necessity for economic survival (pg. 42). Assessing these rapidly increasing needs is an important factor in identifying prime locations for making marina development decisions.

Needs assessment of recreational facilities and resources is dependent on measures of demand and supply. Consequently, there has been a considerable amount of literature published regarding demand and supply research. One objective of recreational demand and supply research is to direct planning and management decisions involving development of facilities and resources.

Recreational demand literature can be divided into two groups, that which deals with demand in an economic sense and that which addresses recreational use or participation independent of price. Demand in an economic sense is a price/quantity relationship. As the price of a recreational experience increases demand decreases. The latter concept, demand as a function of participation, has arisen due to the nonpriced or highly subsidized nature of recreation resources. Defining demand only in terms of a quantity of use or participation is limited but nonetheless useful for determining recreational needs. Needs may be determined by projecting participation and then comparing this future participation with existing facility capacities. Standards or defined goals may also be used to determine needs by comparing measures of participation with a desired condition or set standard (Bannon, 1976: 225).

Another element in assessing recreational needs is an inventory of resources available. In recreation planning literature, this is often referred to as an inventory of "supply". This inventory of resources

available is not the same as the economic concept of supply, which involves a quantity provided at a given price. For most recreation planning inventories, supply is an enumeration of resources available with no consideration of price. Stynes (1983:112) provides a concise definition of this limited supply concept as the measure of variables related to the quantity and quality of recreation opportunities.

Hereafter, references made in this dissertation to demand or supply, pertain to the limited recreation planning concepts rather than strict economic concepts of demand and supply. Use of these limited concepts for needs assessment necessarily leads to a limited definition of needs. Needs in this sense pertain to a relationship between use of resources and availability of resources. This relationship is not the optimal resource allocation combination which economists seek since neither demand nor supply in the economic sense could be identified in this study.

Theoretically, this supply-demand relationship can be expressed as a discrepancy analysis. This type of an analysis includes a measurement of use or participation, an inventory of resources, and a measure of resource capacity for a given time period of use. The discrepancy between use and available resource capacity for a given duration constitutes a need or surplus of facilities. A study such as this was conducted in Orange County, California to identify specific facility requirements (Catalano and Jones, 1979:325). The Orange County needs assessment was concerned with providing a guide for local decision makers in efficient allocation of scarce resources among a variety of activities. Needs for 22 activities were ranked to determine development priorities.

Waterways Division, MDNR, has assessed needs for Michigan Great Lake moorings. Numbers of boats which will use moorings in 1989 were estimated by multiplying the proportion of total registered boats stored at marinas during the 1977 boating season (.392) by projected total boat registrations for 1989. The deficit of moorings was calculated by subtracting the 1977 base number of moorings from the projected number of moorings required for 1989 (Waterways Division, MDNR, 1982:3). The deficit of public sector moorings was then distributed among state planning regions using the distribution of boating use during 1977.

A slightly different approach to assess recreational needs is to develop and apply a need index. The objective of a need index is to assess relative needs. Need indices are useful for ranking areas by their relative needs to set allocation priorities. Relative needs can be determined by comparison of a regional index value to some standard or by making a comparison between two or more regions. Indices have been developed which range from simple ratios of resource to use measures to complex indices which take into consideration a variety of population as well as resource characteristics (Rooney, 1974; Bannon, 1976).

Problem Statement

Those who provide access to boating resources face the problem of measuring boating demand or potential demand and then judging what facilities are needed in what locations in order to meet anticipated needs. To provide effective boating access facilities, planners need ways to monitor boating demand and assess future needs for access.

Currently, numerous Michigan boating studies provide an indication of trends in boating demand and the spatial distribution of demand (Chubb, 1971; Recreation Resource Consultants, 1972 and 1975; MDNR, Waterways Division, 1979; Stynes and Safronoff, 1982). However, to measure future needs for marina moorings, measures of demand or potential demand must be combined with measures of existing facilities. More specifically, to assess needs of marina moorings serving Michigan's Great Lakes, an inventory of available moorings must be combined with measures of current and potential demand for moorings to arrive at assessment indices.

Objectives

This dissertation is concerned with the geographical distribution of Great Lake moorings in Michigan, changes in the number and distribution of moorings from 1978 to 1983, and relative measures of mooring needs for 1978 and 1983. Factors influencing shifts in measures of mooring needs during this period are: 1) change in the mooring inventory, 2) the extent to which this change correlates with prior measures of mooring needs, and 3) spatial shifts in recreational boating demand.

Additional factors which must be considered in an analysis of the distribution of mooring needs are units of measurement used in development of need indices and regions of aggregation. Because any single unit of measurement emphasizes only one aspect of a resource, several indices were developed for this study. Face validity and construct validity of each relative need index were assessed to: 1) evaluate measurements of boating supply and demand included in the need

indices, 2) determine relative distribution of needs, and 3) determine how relative mooring needs are changing over time. Finally, results from two regionalizations were compared to evaluate the impacts of regionalization on the resulting need indices.

This study was designed to first provide an inventory of existing facilities, monitor changes in those facilities, and assess temporal and spatial changes in mooring needs. The final task included an evaluation of the validity of selected mooring need indices and a comparative analysis of two regionalizations to assess the influence of aggregation on the results. Specific objectives are:

1. To determine the spatial distribution of public and private marinas serving Michigan's Great Lakes during the 1983 boating season.

2. To determine changes in the number of moorings provided by marinas serving Michigan's Great Lakes from 1978 to 1983.

3. To measure relative regional marina mooring needs using selected needs assessment indices for 1978 and 1983.

CHAPTER II

REVIEW OF LITERATURE

This research, examines the distribution and changes over time in the number of recreational boat moorings serving Michigan's Great Lakes as well as assesses measures of mooring needs. Mooring needs were assessed based on ratio measures of Great Lakes boating demand, and the quantity and distribution of marina facilities. The research methods which were employed were based on previous studies in recreation resource planning.

Recreation planning is an interdisciplinary field which is a mixture of theory and methods from both the natural and social sciences. It has evolved from these various disciplines to include a rich and diverse body of knowledge. Recreation planning concepts and research methods related to this marina study are discussed in this chapter. Included in this discussion are previous research on marina management and planning and studies on marinas serving Michigan's Great Lakes.

Recreation planning literature is replete with references to theories of supply, demand, and needs which have been the topics of much research and debate for approximately the past 25 years. The basic theories come from economics. However, other social sciences become involved when supply-demand relationships are applied to recreation.

Supply of Recreation

The concept of supply of recreation used for this dissertation was the measurement of the quantity of available marina moorings serving Michigan's Great Lakes. Recreation supply has been most often measured by techniques which use inventories of those physical elements which contribute to recreation opportunities (Cicchetti, 1973; Symonds, 1979; Cordell, Hendee, and Stevens, 1983; Craighead and Craighead, 1962; MacConnell and Stoll, 1969; Olson, 1969; Bell, 1977). In a study of recreational boating supply, Cicchetti, Fisher, and Davidson used acreage of recreational land and water resources to determine supply of boating opportunities (Cicchetti, 1973:59-64). The supply component was a set of variables used as a measurement of the quality and type of water resources in the county and state. Other physical inventories have focused on classification schemes (Cordell, Hendee, and Stevens, 1983; Craighead and Craighead, 1962), inventory and distribution of sites (Olson, 1969; Bell, 1977), and the evaluation of resources (Craighead and Craighead, 1962; and MacConnell and Stoll, 1969).

In a study of the benefits of boat harbor development in Southern California, Symonds (1979) suggested that boating supply is a function of access, which he felt could be measured by the efficiency of the recreational experience. He stated that boating supply is restricted by on-water congestion, availability of storage and mooring facilities, recreation-trip distance, and ownership of a boat. So, according to Symonds, supply is not just the physical resource it also includes the participant's perception of a resource's availability.

Included in this user's perception of supply, is a notion of carrying capacity. Colton, Pitt, Morgan, and Chaney (1979) and Ashton (1971) interviewed boaters to measure participants' perceptions of on-water congestion, as a measure of available opportunities. They also collected physical measures of congestion by counting the number of boats present on the particular lake during the time of the interviews. Boat counts were made from aerial photographs of the lake which were taken at the same time and day as the interviews of boaters. Ashton correlated user attitude measures with a measure of safety and found a significant relationship. There was also a significant relationship between number of boats per acre and the safety measure. Ashton went on and determined a boat per acre carrying capacity measure for a variety of activities using the above correlations.

Beaman, Kim, and Smith (1979) offered a variation from the traditional supply measure and calculated a regional "supply factor" for various activities based on a difference between the observed levels of participation, based on a sample of the residents, and predicted levels of participation. The predicted levels of participation were based on a model using socioeconomic variables of residents in Canada. These predictions were then subtracted from the observed participation rates. The difference between predicted values and sample measurements of participation was a "supply factor", or that portion of participation which could be explained by regional abundance or deficiencies in supply.

Subsequently, Smith and Lazarowich (1980) used the available physical inventories of golf courses in Canada to validate the "supply factors" generated for golf. The researchers felt the study had mixed

results. The correlation between the supply factor and the number of golf courses was 20 percent when 58 regions were used in the regression. However, once the authors aggregated the 58 regions into 9 provinces, the evaluation criterion was improved to a 74 percent correlation. A criticism of this analysis is that the explanatory power of the model did not improve by 275 percent by aggregating the regions, instead this aggregation eliminated variation in the participation among regions (Young and Smith, 1979).

Bevins, Haugh, and Stynes (1977), reviewed an applicaton of this type of "supply factor" for the Northeastern United States. They suggested that these measures are not necessarily supply related at all but rather indicate regional variation in participation (pg. 14).

Smith (1983), in his book Recreation Geography, discussed the supply of recreation resources through a review of descriptive locational research. He grouped the types of research into three categories for his discussion: 1) location of facilities and activities, 2) inventories of physical resources, and 3) description of images or a person's perception of a region and and its available resources. Smith's review points out that the problem of naming, describing, and classifying recreation supply components is complex but also very important to an understanding of the resources. Smith also points out that recreation researchers do not agree on a single approach to the task. In fact, he provides a valid argument for addressing recreation supply from a number of different approaches. By using several measures of supply in an assessment, a broader understanding of the nature of recreation supply may be achieved.

Measurement of Supply Using Aerial Photographic Interpretation

Aerial photographs provide a detailed data source for the collection of recreation resource information. There has been much written on the application of aerial photographs and remote sensing to the management and planning of natural resources (Colwell, 1984; Olson, 1984; Stid, 1974; Benton, Snell, and Clark, 1978). There also have been several studies which used aerial photographs to assess recreational resources and, in several cases, to assess various aspects of boating resources (Draeger and Pettinger, 1981; Dill, 1963; MacConnell and Stoll, 1968; Colton, Pitt, Morgan, and Chaney, 1979; Dunning, 1980; Deuell and Lillesand, 1982). The critical advantage to collection of data from good aerial photographs is that they provide an accurate record of existing conditions at a given time. This record provides a verifiable data set which can be compared to past or future aerial photography of the same resources to determine changes over time. This verifiable data source is critical to the monitoring of resource opportunities.

Natural Resources Planning and Management

There are many examples of aerial photographic applications to natural resource planning and management. A step-by-step procedure for applying this tool, which can be generalized to recreation resources, was set out by Colwell (1984:26-27). Olsen (1984) reviews critical questions which must be answered in selecting the best type of photographic image and analysis technique by considering the purpose of the resource inventory and the information needed by decision makers.

These questions are: what is it the manager needs to know, at what resolution, from how large of an area, and how often? Once these questions have been answered, then it can be determined which remote sensing devices and interpretive techniques would be best suited for the task.

The ability to accurately detect changes in land use/land cover patterns is central to the use of aerial photographic data for planning and resource management purposes. The change analysis approach used by the Genesee/Finger Lakes Planning Board was analytic, using a data set derived from aerial photographs to identify factors influencing development (Stid, 1974). The analysis, in effect, was a series of models which was used to predict future land uses. Future development patterns of the region were mapped based on current conditions and three policy options. This approach looks at the current situation as a baseline from which development can be directed based on the desired policy. This assumes that the current policy can be changed and a new, more desirable one implemented to redirect development.

A different approach to change detection is the use of sequential aerial photographs to document land use/land cover changes. Aerial photographs were used to document land uses on Galveston Island for information to guide future development of the island (Benton, Snell, and Clark, 1978). To make critical planning decisions planners require an understanding of past practices and present conditions. The Galveston Island study methods used current aerial photographs to map existing land use patterns and then compared these to historic photographs. The historic photographs provided a means to collect data on conditions which once existed and which may or may not have existed

at the time of the study. A comparison of the data collected provided a shift in conditions spatially and over time. As the change processes continue, the recent photographs become a verifiable data set to be interpreted at a future time and compared to future photographs.

Recreation Resource Planning and Management

Draeger and Pettinger (1981), discuss the application of aerial photographs as a tool for park planning and management. They describe techniques for location and mapping of resources, monitoring changes, and acquisition of imagery and data. Dill (1963), discusses recreation site characteristics which can be identified on aerial photographs and used to select sites for development. A study conducted in the Northeastern United States for the Outdoor Recreation Resources Review Commission was used to illustrate sampling procedures and inventory techniques. Because of the sampling techniques used (a random sample of 2 percent of the total area) the method only assessed the number of possible sites in a large area. It could not provide information of the distribution or location of these potential sites.

Aerial photographs also were used to identify and classify river-based recreation sites along the Connecticut River (MacConnell and Stoll, 1968). Sequential photographs (10 to 13 year time span) were used to document past uses and development trends. The study demonstrated the feasibility of analyzing the recreational potential of a large river from aerial photographs and illustrated the valuable information which can be derived from time series photographs.

Dunning (1980), evaluated the possibility of refining data needs for the RIVERS Method, a method for assessing river recreation potential, to be solely derived from remotely sensed sources. The technique used in the evaluation was to compare results derived from previous assessments. All data variables and results were derived from using a limited set of variables which can be identified from vertical aerial photographs. The basic conclusion was that remote sensing techniques along with limited field checks can be used accurately and efficiently to assess river recreation potential (pg. 97).

The primary objective of a study by Deuell and Lillesand (1982) was to estimate recreational boating use on an inland lake. In addition to the boat count, aerial images were used to document location of boat moorings on the lake. The authors suggest that future aerial surveys will be used to record changes in this shoreline use.

Marina Resources Inventories

Previous marina studies which were reviewed provided information on the physical character of marinas within a given area or the financial status of a group of marinas in a specified geographic region. The marina studies reviewed have included several statewide and regional inventories. An analysis of the New York City marina situation was also included.

Numerous studies have investigated specific aspects of the marina industry for particular geographic regions (Szmedra, Brown, and North, 1983; Milon, Wilkowske, and Brinkman, 1983; Espeseth, 1980; Meltz, Schink, and Somersan, 1980; Kreag, 1983; and Crompton, and Ditton, 1975; McKinney, 1979; Gardner and McCoy, 1974; West and

Heatwole, 1981; Goodwin and Stokes, 1980). The data collection method which was used in most of the studies reviewed was a survey of the marina managers or other marina personnel. These surveys were conducted, in some cases, in conjunction with on-site inspections. In some of the studies, the data used in the analysis were from secondary sources or updates of historic records by "knowledgeable" individuals in the industry. These methods were used to meet two broad objectives found in the studies reviewed. A large number of these studies were concerned with the management and finance of marinas. Other studies reviewed were descriptive in nature focusing on facilities and location of marinas within a region.

The studies which addressed management and financial concerns of the marina industry were reviewed to determine data needs of industry decision makers and how facility and capacity data were collected. All these studies used survey techniques for data collection (Szmedra, Brown, and North, 1983; Milon, Wilkowske, and Brinkman, 1983; Espeseth, 1980; Meltz, Schink, and Somersan, 1980; Kreag, 1983; and Crompton, and Ditton, 1975; McKinney, 1979; Gardner and McCoy, 1974; West and Heatwole, 1981). Response rates for surveys were relatively low for all of these studies. The return rate in one of the studies was 26 percent which made it impossible for a comparison with previous data collection efforts (Kreag, 1983). The analysis implied that moorage had declined in the state when in fact it had increased. The author defended the results as a valid random sample. However, he attributed the discrepancy to the fact that the sample was biased toward the smaller marinas. This bias had lowered the state totals when the sample was expanded to the population.

The management studies reviewed, all used a secondary data source for numbers of moorings and marinas in the geographic region of interest. The studies analyzed the data from the samples on a marina level and on a per mooring basis. Then the findings were generalized to the total population of marinas. From this review, it was determined that marina industry decision makers are in need of: 1) accurate regional counts of mooring capacity, and 2) monitoring of these data to keep them up-to-date and for analyzing development trends.

The second type of marina study centered on the facilities and geographic location of marinas. The data collection for these studies were conducted through on-site surveys of marinas. There was also a study which used secondary marina data to analyze changes in the geographic distribution of moorages over a 12-year period. These studies were conducted to provide the boating industry of the region with an empirical base against which boating trends in services provided can be monitored through time (Waterways Division, Michigan Department of Natural Resources (MDNR), 1977; Crompton, Beardsley, and Ditton, 1976; Goodwin and Stokes, 1980).

The inventories of marinas serving Michigan's Great Lakes and Texas' Gulf Coast were similar in that they provided a listing of facilities, numbers of slips, type of management, name and mailing addresses, and geographic or county location information for each marina included in the inventories (Waterways Division, MDNR, 1977; Crompton, Beardsley, and Ditton, 1976). The major difficulty with this type of process was pointed out by Crompton, Beardsley, and Ditton in that "while every effort was made to cross-check the material, the 2,500-mile length of the Texas Shoreline makes omissions possible" (p. 5). The

same was true for the Michigan inventory (Waterways Division, MDNR, 1977).

The review of the moorage industry in Washington's coastal zone relied on two secondary sources of data (Goodwin and Stokes, 1980). The study was concerned with relative change in the industry so the data sources did not need to be absolutely complete but were assumed to be comparable. The authors did, however, point out in an endnote that the data set for the earlier time (1966), was incomplete for certain regions of the coast. This discrepancy in the data sources resulted in an analysis of only a portion of Washington's moorage supply.

Data analyses for these studies were descriptive and included regional summaries of marinas, facilities, and moorage. The Michigan and Texas studies included listings of the mailing addresses and a contact person for each marina. The Texas study also included a map location for each marina. These two studies represent the baseline for the mooring industries of these states.

The Washington State study took the analysis one step further and looked at changes in moorage over time. The changes in moorage were presented as percent change by county and each county's share of the growth. The data were also analyzed on the basis of moorage spaces per thousand households in each county. The county aggregate data were also compared to the state average to come up with a relative value which could be compared among counties. This analysis was in the form of a comparison between the actual number of moorings and the number of moorings expected if every county had the same ratio of moorings to households. The number of moorings above or below this "expected" number were relative values useful for regional comparisons among counties (p. 13).

The Texas and Michigan studies provided information on the current situation of moorage and the Washington study provided an analysis of how things had changed in the moorage industry. The Washington analysis also provided an indication of relative boating access by comparing a measure of moorage per thousand households for each county. These studies did not, however, relate the supply of moorage to boat use. There was no analysis in any of the studies as to the geographic distribution of the use of the boat fleet or the distribution of residence of the boating population. The analysis of the boating fleet should also relate the changes in the use of the fleet over time to changes in the stock of moorage in a region. These are important aspects which should be addressed in an analysis of the supply of boating opportunities.

Supply of Great Lakes Boating in Michigan

The supply of recreational boating opportunities in Michigan (i.e., what is provided by public and private concerns in the way of services, facilities and access to boating resources) has not received much attention in terms of research. Two reasons contributing to this lack of information are: 1) there is some difficulty in deciding a priori upon the proper definition of supply for boating and 2) the numeration of recreation resources in the form of inventories is generally difficult. However, there seems to be some agreement among researchers, that moorings and storage for boats is a factor in the supply of boating opportunities. Therefore, the available moorage space providing access to Great Lakes boating in Michigan was used in this study as a measure of the recreational boating supply.

The second factor which has led to the lack of marina supply data in Michigan is the difficulty involved in executing an inventory of recreation resources. An inventory of resources is influenced by development of new facilities and the closing of others which keeps the level of recreation opportunities in a constant state of flux. Any effort to develop a one time inventory of recreation opportunities becomes out of date as soon as it is completed. An example is the Ontario Recreation Supply Inventory which took years and hundreds of thousands of dollars to accurately count recreation resources in the province. The inventory was never completed, becoming more and more out of date as time progressed and opportunities changed. This is unfortunate given the time and expense of this effort. However, the criticism is not of this effort, but rather of what it represents, an inherent difficulty with the recreation resources inventory process (Smith and Lazarowich, 1980:122).

Recreation inventory studies tend to be defined entities and as soon as they are "finished", as per stated in the study objectives, they begin to erode into the status of an historic secondary data source. Even though these secondary data sources can play an important role in the analysis of time series data, there must be a systematic monitoring of resources to identify responses to management decisions (Stynes, 1983:93). Unfortunately, there has been no research effort which has systematically collected and analyzed Michigan Great Lakes recreational boating supply data on a periodic basis.

There have been a few primary data collection efforts, to date, which have addressed selected segments of the supply of boating opportunities in Michigan. Waterways Division, MDNR, administers grants

to develop municipal harbors and a few harbors are under its jurisdiction. Periodically, the Michigan State Waterways Commission publishes a report which documents the harbors of refuge and municipal mooring facilities provided in the state (Michigan State Waterways Commission; 1959, 1963). In addition to these official reports, the Commission annually publishes a harbors guide for boaters. This guide includes information on the state and municipal harbors serving Michigan's Great Lakes. Similar documentation is provided by the U.S. Army Corps of Engineers as a summary of its water resources development projects which provide recreational access to the Great Lakes in Michigan (U.S. Army Corps Of Engineers, 1957). These official reports and harbors guides represent a limited segment of the moorings available to Great Lakes boaters and provide little toward the assessment of total boating opportunities in Michigan. They are only designed to provide information on those facilities provided through public support.

There are harbors guides published annually by the private sector such as the Yachtsman's Guide to the Great Lakes which provide information of the locations, services, supplies, facilities, and amusements at selected marinas around the Great Lakes. This harbors guide also includes only a portion of the marinas and boating opportunities available on Michigan's Great Lakes. These private harbors guides are published to provide information to the boating public, not to assess all marinas and total moorings available.

A special Riverfront Development Task Force study inventoried, analyzed and evaluated the current status and future potential for the Detroit Riverfront corridor (Interagency Task Force for Detroit/Wayne County Riverfront Development, 1976). As part of this assessment all

marinas on the riverfront were identified along with information which included: number of slips, number of boats moored, and boats in storage during October 1975. This inventory was completed through interpretation of low altitude aerial photographs. The 35mm color slide images of the riverfront provided a detailed data source. Although the Detroit Riverfront inventory is localized, it represents a significant effort for providing marina information.

There are a few marina lists which have been completed to provide the number of marinas available, and in one case, to provide some information on the number of moorings, services available and facilities at marinas serving Michigan's Great Lakes. The most recent of such lists was compiled as a sampling frame for a study on the influence of fuel price and availablility on Great Lakes boating behavior (Fridgen, Taber, and Gillings, 1982). This list provided a means for counting, by county, the numbers of marinas serving the Great Lakes and inland lakes of Michigan. There was an attempt made to make the list dynamic in that the list was stored on a Mag-Card typewriter system so that it could be easily updated. There was also a form published with the document of the list to be sent to the authors for additions, corrections or deletions to the list. To provide some method for updating these data is an important aspect of inventories which is, for the most part, overlooked when methods are designed and implemented.

The Waterways Division, MDNR conducted a Great Lakes marina inventory during 1977 which included the names, mailing addresses, moorings available, services, facilities, and other information on marinas (Waterways Division, MDNR; 1977). This has been the industry standard in the state, being the most complete collection of marina

information to date. The results of this inventory have been used as a secondary data source for the industry in several studies (MDNR, 1979; Fridgen, Taber, and Gillings, 1982; Stynes and Holecek, 1982). There were several difficulties with these data. The list was by no means a complete listing of all marinas serving the Great Lakes in the state, and there was no systematic way of updating the records. There was also no means of determining how the industry was changing geographically or over time.

Other sources of marina data in Michigan are those agencies which are responsible for providing permits for construction of marinas in the state. There are four government agencies which must review and give their approval on any marina construction project in Michigan. These agencies are the United States Army Corps of Engineers, MDNR and Michigan Department of Public Health (MDPH), and the local government body with responsibilities for planning.

The state agencies maintain files of permit applications and approvals. However, these do not reflect the number of marinas built and certainly do not represent the level of current development at any given marina. The reason for this is that marina owners generally apply for and receive permits to build more moorings than they actually construct. This allows for expansion at a future date without the need to go through the lengthy application procedure for an additional permit (Rood, 1977). An analysis of permit materials would provide an idea of the potential number of moorings if they were all constructed. But, this review would not reflect the true supply. In addition to this discrepancy between the number of moorings provided and the number permitted, it is suspected that there are marinas in the state which are

operating without a permit. These marinas would not be included in an analysis of the permits to operate issued by the MDNR, Lands Resource Programs Division or the MDPH (Feldhauser, 1983; Reck, 1984).

The inventories and marina lists which existed prior to the 1983 marina inventory were not complete. They did not provide, even in aggregate, a data set which could be assessed in conjunction with boating activity data. There were additional data and analysis needs which had to be met before supply of recreational boating opportunities could be used with measures of demand for Great Lakes boating in Michigan to assess mooring needs. The first data need was a current accurate inventory of the marinas serving Michigan's Great Lakes. This inventory had to be in such a form that it could be updated and verified in a systematic manner. The second need was an evaluation of measures of mooring needs. This evaluation was to provide a better understanding of the relationship between marina mooring supply and the demand for recreational boating on Michigan's Great Lakes.

These previous studies indicate that measuring recreation supply involves a complex set of physical resources, users' perceptions, constraints, and opportunities. How best to measure these and then incorporate them into the recreation resources planning process is a significant and timely question for recreation researchers to address. The Outdoor Recreation Resources Review Commission recommended in 1962 that the Bureau of Outdoor Recreation (BOR), be created to: 1) establish a nationwide survey of recreation supply and 2) encourage research efforts that would lead to a better understanding of the components of recreation and the processes which mold the national recreation delivery system (Mitchell, 1983:337). While these duties of the BOR, later the

Heritage Conservation and Recreation Services, have been moved to other agencies (U.S. Forest Service and National Park Service), these two tasks are no less urgent. Advancements toward the achievement of these objectives will continue to contribute to the overall understanding of the recreation system.

Demand for Recreation

The concept of demand provides a measure of recreation which focuses on the behavior of recreationists. There is some debate in the literature, however, as to how the concept should be applied to recreation. Some researchers rely on economic approaches which derive aggregate marginal value curves from a schedule of observed or expressed willingness to pay values. These approaches fall into two classes (Freeman, 1979): 1) the analysis of market transactions which have substitute or complementary relationships with a recreation experience or site (Clawson, 1959; and Clawson and Knetsch, 1966) and 2) the contingent valuation approach which asks participants to identify their willingness to pay for specific levels of participation (Bradford, 1970; Daubert and Young, 1981). These approaches are useful in site valuation, location, and development decisions.

Indirect market transactions were first used in the valuation of recreation at particular sites by Clawson (1959), and Clawson and Knetsch (1966). These studies relied on travel-costs to a site for a relevant measure of the price for services at the site. Willingness to pay is derived from travel and time costs involved in getting to the site. Major assumptions of the model are that all recreationists at the site have access to as much of the site's services as they want, that

each individual spends the same amount of time at the site, and that characteristics of the site remain constant during the season. Despite these assumptions, the observed results from some applications of the model to estimate benefits of alternative decisions seems to be adequate in some instances (Smith, 1975:101-102).

The direct measure of willingness to pay methods arose from benefit-cost analysis for public goods (Bradford, 1970). Daubert and Young (1981) apply the contingent valuation method to stream flows and recreation fishing. Through a bidding procedure, a total willingness to pay function was derived. This function relates the anglers' preferences for various levels of flows and an aggregate value for maintained flows. The results from this analysis provides water resource managers with a measure upon which to base timing of water releases from high mountain reservoirs and water allocation decisions.

Another approach to demand for recreation is to define it in terms of consumption and participation. This concept of demand was discussed in Chapter I (p. 2). Coppock and Duffield (1975:4) define recreational consumption as a measure of use at a particular destination (use of resources), while recreational participation refers to residents of a specific area. So, participation defines, for a particular population, the proportion of that population that engages in a recreation activity.

An example of a population based participation study was presented by Halstenrud (1980). In his study, he compared levels of participation in sports during three time periods. These comparisons were used to predict the future number of participants in any given sport, and to profile the players by several demographic characteristics (p. 195). This analysis of data over several time periods allows for tracking of

trends in these demographic variables. The demographic shifts taking place can influence business decisions such as which marketing and promotion strategies are selected. Comparison of shifts in demographic characteristics of the participants and in the overall population can be used to predict where participation in a particular activity may be headed. Time series analysis overcomes the primary problem with using cross-sectional data for projections which is the necessary assumption of a constant activity participation rate.

Time series analysis has also been applied to population participants in hunting and fishing (Brown and Wilkins, 1975). The authors correlate exogenous variables with participation to illustrate how management might adjust variables over which they have control to modify future levels of participation. Hunting and fishing license sales for three decades were used as indicators of participation. The time series models derived provided reasonable projections due in part to the incorportation of changes in participation rates over time into the model.

Demand for boating in the general population in New York City was assessed through the use of several secondary data sources (West and Heatwole, 1981). West and Heatwole used marketing studies which estimated the number of persons in the United States who were likely prospects for the purchase of a boat (Yankelovich, Skelly and White, Inc., 1979). The proportion of total demand for boating was then calculated by using the proportion of outboard motors sold in the United States which were sold in the New York City area. The result was then adjusted for replacement sales. The method used in this study is rather crude but, as stated by the authors, the objective was not to determine

a specific number of individuals who might be boaters. Rather they sought to measure the magnitude of potential boating demand.

Included in recreation literature has been the argument that demand for recreation cannot and should not be defined in economic terms of rational behavior of individuals with perfect knowledge. Rather, recreation demand should be defined in terms of choice behavior based on recreationists' limited information and circumstances (Hof, 1979:450). After all, recreation and leisure are segments of human behavior that are characterized by freedom of choice and non-instrumental satisfaction (Kelly, 1980:152). Methods for assessing recreation in relative economic terms have been used to determine the willingness of recreationists to pay for experiences. These techniques have been useful in allocating resources among several alternatives. Knetsch (1970:134) suggested the demand for activities and facilities should be defined in such a way that providers of recreation opportunities can make rational policy and investment decisions to meet the expressed desires of their publics. There should be some direct link between the demand for recreation and the resources provided through an assessment of recreational needs.

Demand for Great Lakes Boating in Michigan

A number a studies have been conducted which looked at the demand for boating on Michigan's Great Lakes and the impact of this demand on the Michigan economy. The participation studies have been an attempt to provide longitudinal data for boating trend analyses. Studies concerned with various aspects of the economics of boating were focused on the impact of dollars spent for boating in Michigan and on the feasibility

of new facility developments and the impacts they may have on regional boating participation.

Waterways Division, MDNR and Michigan Sea Grant have sponsored statewide surveys of boaters every three years from 1965 to 1980 (Waterways Division, MDNR, 1966; and 1979; Michael Chubb, 1971; Recreation Resources Consultants, 1972 and 1975; and Stynes and Safronoff, 1982). Boating information has also been collected by the Recreation Services Division, MDNR through general statewide recreation surveys. These surveys have been conducted for recreation planning purposes since 1975 with various types of boating participation receiving attention (MDNR, 1975; 1979). In aggregate, these surveys provide a comprehensive set of trend data for boating use in Michigan.

There have also been a number of studies which have focused on the economics of boating. Direct boating related expenditures of registered boat owners in Michigan was estimated to be just under one billion dollars during 1981 (Stynes, Brothers, Holecek, and Verbyla, 1983). Other studies have looked at specific segments of the boating expenditures such as mooring costs (Han, 1975; Recreation Research and Planning Unit, MSU, 1971), gasoline purchases (Chubb and Wenner, 1971; Fridgen, 1982; Mannesto, 1981), and the economic impact of a boat and fishing trade show (Gartner and Holecek, 1980). Still others have looked at the economic impacts of boating in selected regions (Warner, 1974; Department of the Army, Corps of Engineers, 1974).

Stynes and Safronoff (1982) addressed the regional market shares of boating participation in Michigan for 1980. Their analysis was based on mailed questionnaires returned by registered boat owners in Michigan. The boat owners responded to a question of where they had gone boating

during the 1980 boating season. These destinations were then assigned to the region of residence to produce a origin/destination table of boating days generated from each region to each region. This not only provides information on which regions are importing or exporting boating occasions but also serves as an indication of the location of boating opportunities around the state. Results from the Stynes and Safronoff analysis and from a similar study done by Waterways Division, MDNR (1979) were used in this study of marinas as a means of measuring Great Lakes boating demand.

These recreation studies of boating demand, boating participation and the economic impact of boating provide an information base for policy direction and a means for guiding and setting priorities for program development. A statement of needs for future development of boating opportunties was not provided in any of the studies cited above; however, the intention and implication was there. The motivation for studies such as those reviewed was, as Knetsch put it in his chapter in Elements of Outdoor Recreation Planning, "to yield estimates of forecasts for improving or adjusting the supply of recreation opportunities, and to estimate the probable effects of alternative programs and policies" (1970:134).

Recreation Needs Assessment: Relating Supply and Demand

Included in the recreation planning literature on supply and demand are a number of theories and methods for making a link between the resource and its use. The primary goal in supply and demand analysis is the assessment of the needs of the consuming public. The shortcomings of approaches taken to assess recreation resource needs have been well

documented by Knetsch (1970) and more recently by Arbeit and Gangaware (1982). To quote Knetsch, "the single most serious and most fundamental deficiency in most demand surveys and studies is that they do not provide any means of determining how recreation use will respond to changes in supply..." (1970:135). In short, they do not provide a viable means for assessing the needs relationship between supply and demand.

Arbeit and Gangaware (1982) reviewed the needs or discrepancy evaluation methods available to recreation planners. The problems they identified with the most commonly used methods were that most recreation needs assessments are done on a regional basis, that they emphasize participation in recreation rather than the desire to participate, and finally, that there is no provision made for ranking of needs spatially or among a variety of activities. While the discrepancy analysis is the most widely used in recreation research, there are other assessment techniques available. These include goal rating procedures, key informant, community forum, and social indicators. The authors point out that interactive employment of several methods would add to the validity of a needs assessment. The method selected should be dependent on the objectives of the assessment. However, no matter what the objectives, at the end of the prossess it should be possible to answer: Who needs what as defined by whom? (p. 22).

A difficulty in the recreation needs assessment process arises due to the fact that the provision of recreation resources is a mixture of public and private offerings. The marina industry serving Michigan's Great Lakes is an excellent example of the public and private sectors both providing similar recreational opportunities. The public marina

sector, as with public provision of any recreation opportunity, is influenced by noneconomic factors which are determinates of the quantity of recreation opportunities supplied. If the public sector agencies are responsive to levels of use, then Hof (1979:456) presents the set of factors determining supply as:

$$Q_c = f(P, X_i, Q_p) \quad \text{and} \quad Q_p = f(Y_j, Q_c)$$

where: Q_c = the quantity of boating opportunities actually consumed

Q_p = the quantity supplied by the public sector

P = Price paid for the boating opportunity

Y_j = the political, financial, or precedent variables affecting public sector decisions

X_i = traditional demand shifters

This quantity supplied/quantity consumed relationship reflects the traditional public sector policy to maximize social rather than profit motivated goals. Thus, needs in the sense of new public sector development are determined through an assessment of the response to available resources. On the other hand, the private sector of the marina industry is profit motivated and should therefore be subject to the traditional supply/demand relationship:

$$Q_s = f(P, Y_j) \quad \text{and} \quad Q_d = f(P, X_i),$$

where: Q_s = quantity supplied by the private sector

Q_d = quantity demanded by the boating public

P = Price paid for the boating opportunity

Y_j and X_i are supply and demand shifters respectively

This quantity supplied/quantity demanded relationship is a strict price oriented response by both the private sector marinas and the boaters (Hof, 1979:448). The facility or boating opportunity needs assessment process relies on these two very different supply/demand relationships. If a supply component could be included into a demand analysis the consumers' responses to changes in supply could be predicted (Bevins, Haugh, and Stynes, 1977:13).

One method which may be used to bring supply and demand components together to assess needs and which has only recently become common in recreation literature is market share analysis. Market share has long been a key variable in business management strategy formulation. Most major corporations direct their long term objectives toward the proportion of the total market they can capture through the sale of their products (Warnick and Howard, 1985). The most important aspect of market share analysis, from the point of view of recreation resources planning, is that it can provide valuable information into the trends in provision of recreation facilities, such as marina moorings, and general use patterns of the consumers.

Warnick and Howard (1985) investigated shifts in market shares of public and private providers of golf, tennis, and racquet ball from 1979 to 1982. They placed emphasis on the usefulness of the information for a marketing information system and development of marketing strategies. They found that overall participation rates had declined for golf and tennis while they had increased for racquet ball. The data analyses also revealed the majority of the occurrences were generated by a small proportion of the participants. This type of an analysis provides information on the primary users of a resource and the primary providers

of resources or services. In this sense, markets are those persons who participate in a given activity, however, markets can also be defined in terms of a location. This is perhaps a more appropriate definition when analyzing natural resource recreation or a resource such as Great Lakes boat moorings which are directly dependent on the Great Lakes water resource.

Great Lakes Mooring Needs in Michigan

To assess long range capital outlay needs for the agency's public access program, Waterways Division, MDNR, predicted future boating demand to anticipate facility needs (Waterways Division, MDNR, 1982). Boating registration trends were projected to estimate numbers of boats which will be registered in the future. Results of the 1977 Michigan Recreational Boating Survey were used to determine numbers of boats stored in the water during a boating season by size and storage location. Making the assumption that the percentage breakdown by size and storage location will be the same in the future, the proportions were multiplied by the predicted number of boats registered in the future. These products were an estimate of the number of boats in the future which will require seasonal moorings.

In the Waterways' Division study, a discrepancy evaluation was used to assess future mooring needs. The number of moorings available, from the most recent inventory, was subtracted from the number of craft needing moorings in the future to determine mooring needs. The market share distribution from the 1977 inventory of marinas, by type (i.e., public, commercial, or club) of marina, was multiplied by the needed number of moorings to determine the number of public sector moorings

needed in the future. This distribution of needed moorings was made under the assumption that each marina sector will maintain its market share.

Mooring needs in the public sector were distributed spatially around the state based on estimates of Great Lakes boating demand. Recreational boating demand on the Great Lakes was determined from boat owner's responses to the 1977 boating survey.

This type of a discrepancy analysis has shortcomings which can be avoided. The most serious is the assumption that the spatial distribution of the proportion of boats using moorings will remain the same. If this assumption is made, it implies that the current situation is ideal and that there should be just more of the same thing in the same places. A relative assessment of recreational needs, based on supply/demand indices, avoids this shortcoming by assuming that regions with high relative needs should receive additional resources. This method of allocating recreational resources minimizes discrepancies among regions.

CHAPTER III

METHODS

Findings of this research came out of analyses of Great Lakes marina mooring inventories from 1978 and 1983, and an assessment of needs indices based on ratios of moorings to various surrogate measures of demand or potential demand for moorings. Discussed in this chapter are procedures used in conducting the inventories and the analyses. The marina inventory for the 1983 boating season is presented first, followed by a presentation of the monitoring and change analysis procedures. The selected needs assessment indices are then discussed in the third section. Evaluation criteria for assessing the validity of the various needs indices are discussed in the final section of the chapter.

1983 Marina Inventory Methods

Methods for conducting the 1983 marina mooring inventory were selected based on their suitability for collecting data from a wide distribution of locations and within a reasonable time period in order to isolate time as a variable in the analysis. Previous detailed marina studies had been completed which used field inspections and/or mail questionnaires for data collection (Michigan Department of Natural Resources (MDNR), 1977; Fridgen, Taber and Gillings, 1982). These

methods have serious drawbacks which were discussed in the previous chapter under the review of literature covering inventory procedures.

There were two major reasons for selecting an alternative to a field inspection inventory approach. A land based field inspection, such as the one done for the 1977 Michigan marina inventory (MDNR, 1977) or the 1976 Texas marina inventory (Crompton, Beardsley, and Ditton, 1976), would have required a considerable amount of travel along Michigan's 3,200 miles of Great Lakes shoreline. The problems of logistics of a systematic field inspection and the possible omissions which could result from missing small facilities in remote areas were restrictive. The main restriction, however, was the lack of funds to support a team of interviewers which would have been needed to collect these data in a reasonable period of time.

There was also another potential problem in data collection and verification using field inspections. Since the vast majority of marinas serving Michigan's Great Lakes are private facilities, allowing an inspection of a marina for data collection would have been a voluntary action. Complete cooperation from marina operators would have been needed for a complete inventory. Such cooperation was considered to be unlikely due to the exclusivity of many of these marinas and yacht clubs.

A mail questionnaire was not considered a viable alternative for data collection because of the high nonresponse rate of previous marina studies and because no complete mailing list was available for marinas serving Michigan's Great Lakes. Mail questionnaire responses are also very difficult to verify without some type of site inspection.

Due to limitations of field survey methods and mail questionnaire techniques, aerial photograph interpretation techniques were selected as the basis for data collection. This data collection methodology also has some limitations, which were discussed along with its advantages, in Chapter II. Four advantages to using aerial photographs for inventorying resources are: 1) good photographs provide a permanent, accurate record of what existed at a particular time, 2) this record can be obtained at a relatively low cost (Shafer and Delger,1986; Harman, Fuller, Tsuchigane, and Fuller, 1980), 3) a large number of photographs can be taken in a relatively short period of time, and 4) the actual data collection occurs not in the field but rather under controlled conditions.

Definitions

Prior to inventorying any resource, a precise definition of what the resource is must be formulated. The scope of and time frame for the inventory must also be specified. Marinas can and have been defined in a variety of ways. Criteria used in developing this definition of a marina serving Michigan's Great Lakes were based on needs of the funding agencies, limitations of the remote sensing techniques used and time and budget constraints of the project. For this research a marina is: any facility having at least six wet moorings, located in a Michigan county which has Great Lake's shoreline, is on navigable waters having access to the Great Lakes and their connecting waters, and for marinas on the Cheboygan River downstream from the M33 highway bridge (see Appendix A for maps of the upstream limits).

Wet moorings include finger docks, broadside moorings, and buoy moorings. Finger docks generally provide mooring for two boats, one on each side. This did not hold in the following two situations where only one mooring was counted per finger dock: 1) if there was only room for one boat between the two docks, and 2) on the last dock in a series where the outside of the dock is to the open water. When this end dock was large, it was considered broadside mooring rather than slip mooring.

Broadside moorings were defined as twenty-five feet of dock or seawall which could be used as mooring. These moorings did not include broadside docks adjacent to launch ramps or haul out facilities. These are used as temporary mooring for loading and unloading and for this reason were not included.

Buoy moorings, floats near marina facilities for the purpose of mooring boats, were also inventoried. Numbers inventoried for these moorings may be slightly inflated because there are buoys for hazard and no wake zones which can not be distinguished from buoy moorings.

Aerial Photography Techniques

The marina inventory was collected from a set of large scale, low oblique aerial photographs taken during the summer boating season; June through September, 1983. In a report on monitoring landscape change, the use of oblique aerial photographs was discouraged for several reasons, the most important of which was that they could not be tied to the over all landscape (Tourism and Recreation Research Unit, 1983). That is to say that oblique imagery is usually of spot features of special interest. As such, they do not provide a comprehensive record of an entire area. To tie the photographs taken for this marina study

to Michigan's entire coastline, a previous set of aerial photographs was used which cover the entire state. Acquisition of these oblique photographs and the resulting marina inventory required planning, coordination and skill on the part of several individuals.

Flight planning was necessary prior to flying the coastline and rivers providing access to the Great Lakes. Locations of marinas were identified on medium altitude (representative fraction 1:24,000) color infrared photographs which were shot between 1977 and 1980. These photographs were made available for this research by Lands Division, MDNR. Marina locations were identified on these photographs by groupings of boats anchored near shore or linear structures built out over the water. The locations were marked and numbered on available United States Geological Survey (USGS) map sheets of Michigan's coastline. Maps which were used had representative fractions of 1:62,500 and 1:24,000 and were mapped at various times. These maps were then used to plan flight duration and to direct the flights along the coast to the marinas. It was determined that due to the stress of in flight maneuvers a five hour flight was optimal for both pilot and photographer.

Flights were taken in a Cessna Skyhawk which is a highwing monoplane. This aircraft type is satisfactory for unobstructed low olique photography from either side window of the rear passenger's seat. The flight operations were handled by a minimum of three persons; the pilot, a photographer, and a coordinator/navigator. When flights were in areas where there was heavy air traffic, such as the Detroit River, two pilots were used. One of the pilots communicated with the air traffic controller while the other flew the plane. This arrangement

worked well in spotting other air traffic in the vicinity and minimized anxiety levels of the crew.

To properly position the airplane for photographing marinas, the pilot had to have a complete understanding of the photographic requirements of the project. He had to know approximately what the photographer in the rear seat was seeing through the camera view finder and ultimately what the photo interpreter would be looking at on the light table. This responsibility did not solely fall to the pilot; it was a coordinated effort. The three crew members communicated during the photographing of a marina via a set of hand signals. As the airplane approached a marina, it was pointed out by the navigator to both the photographer and pilot. When the plane was in position, the pilot was instructed to maneuver the plane so as to provide the optimal position for the photographer. This was, in most cases, a bank to either side which allowed a near vertical shot to be taken.

To take suitable photographs of the marinas, the photographer had to also be aware of the requirements of the project. All the facilities of interest for the inventory had to be visible in the photograph. Examination of photographs taken during a test flight revealed that a critical aspect of taking the photographs was the sun angle relative to the camera lens axis. Reflection of the sun off the water at inappropriate places can obscure the image of a marina. So, the photographer's responsibilities included: 1) minimizing the glare from the sun off the water, 2) shooting when the view of marina structures was unobstructed by trees or other objects, and 3) insuring that the entire marina was covered by the photograph or set of photographs.

Flying altitude and camera angle were not uniform among the images so that a wide variety of marina sizes and arrangements could be imaged on a single photograph. This resulted in different scales for each of the images. Working with a single image for each marina was more important than having a uniform scale among the images. The photographer overlapped multiple frames of clustered marinas by a reasonable margin (20 to 50 percent) to insure complete coverage of each marina in the cluster. The limits of each marina on these photographs were identified during interpretation. Different marinas were identified using one or a combination of the following marina characteristics: 1) use of different construction materials, 2) structures or space which physically separated the marinas, and 3) location of land based facilities relative to moorings.

To minimize difficulties with changing film, and to insure against an equipment failure, at least two cameras were taken on each flight. Cameras used were 35mm SLR each equipped with a 50mm lens. Photographs were taken using Kodak Kodachrome 64 ASA slide film.[1] The transparencies were slightly underexposed, one f-stop, to produce a denser image. This denser image was more comfortable to view while doing the photo interpretation.

The coordinator/navigator had the responsibility of directing the flight, locating the marinas to be photographed, and for keeping a log of the photographs as they were taken. The separate map sheets were arranged in a geographical order to enable a systematic process of locating marinas and adjacent map sheets while in flight. When a new

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[1] Mention of a brand name does not imply endorsement by the author.

marina, one not marked on a map sheet, was spotted during a flight it was photographed, and its position was located and marked on the map along with its photograph identification number. To help document the photography, the coordinator/navigator made up identification cards which were photographed with the last picture of each roll. These identification photographs recorded on the film roll: numbers, dates, areas of the state, marinas, and frames used. The first photograph on each roll of film recorded the roll number and the date. The in flight record kept track of the date, flight number, frame and marina photographed for each roll of film. This duplicate record allowed for easy identification of the slides.

Following each flight, the slides were processed, inspected for suitability, and cataloged. The processing was standard Kodak processing for Kodachrome 64 ASA slide film which was done by Kodak. The first step in the slide inspection procedure consisted of insuring that each marina had been photographed. Then, each marina slide was inspected to determine if all facilities of interest were visible. Finally, cataloging of the slides included recording on the slide mount the date of the photograph, the photograph indentification number and the marina's identification number.

Aerial Photo Interpretation

Photo interpretation and data recording followed criteria based upon elements of aerial imagery described by Avery (1977) in Interpretation of Aerial Photographs. Variables inventoried were derived from planning needs of the funding agencies, previous

inventories, and based on the constraints and limitations of the aerial photography. (See Appendix B for a listing of variable codes.)

Interpretation of aerial photographs is the art and science of studying and identifying objects formed as images of photographic film and evaluating their significance. There are several diagnostic characteristics of an object's image which contributed to its photographic interpretation. These characteristics are: shape, shadow, tone, pattern, texture, size, location, stereo effect, resolution, and association or surroundings with other logically related objects. These attributes of an image, together with the interpreter's knowledge of marinas, and collateral information lead to identification of an object.

Variables collected from the photographs were based largely on the needs of the funding agencies. These variables included the presence of specific types of facilities as well as the numbers and types of moorings. Variables collected on the basis of availability were, launch ramps, haul-out facilities, covered dry storage, open dry storage, and recreational facilities. Mooring facilities were recorded in the following categories: wet slips, broadside moorings, and buoy moorings. Wet slips were inventoried in four size classes; less than 20 feet, 20 to 30 feet, 30 to 40 feet and greater than 40 feet. These size classes were selected because they had been used in previous studies of Michigan marinas (Waterways Division, MDNR, 1977; Stynes and Safronoff, 1982).

The scales of the low oblique aerial photographs were not uniform due to variability in altitude and camera angle, as discussed above. Therefore, slip size classes were estimated based on the relative image sizes of adjacent objects, i.e., automobiles, parking spaces, and boat types. For example, a parking space is generally 10 feet wide and 20

feet long. Marinas typically have parking available for the clientele and these were imaged on the photographs. Images such and these provided a scale, as such, to judge lengths of slips. The length of broadside moorings were also estimated using this comparison method. In cases where there was no object of a known dimension adjacent to the slips, this method was not possible. In these cases, features on the photographs were correlated with the same features on the conventional photogrammetric images. Measurements were then taken from the 1977 to 1980 set of vertical aerial photographs. The vertical set of photographs permitted reliable measurement because the scale of the vertical aerial photographs did not vary to the same extent as that of the oblique photographs.

Groups of buoy moorings were also photographed. These moorings were assigned to the nearest marina facility. This provided for the identification of the location variables for these moorings. Variables collected were also related to the specific location of marinas. These were General Land Office Survey information (tier, range and section), Great Lake served (Appendix C), Great Lakes recreational boating regions illustrated in Figure 1, and county. These variables were taken from the USGS map sheets.

Analysis of these data was based on descriptive statistics of the different marina variables collected. These statistics are reported for the state as a whole, Great Lake served, Great Lake boating region, and by county. These data provide a means for comparing specific sites at different times and for comparing and contrasting aggregated data among geographic areas and time periods. These data also are used as supply measures for assessing temporal and spatial Great Lakes mooring needs.

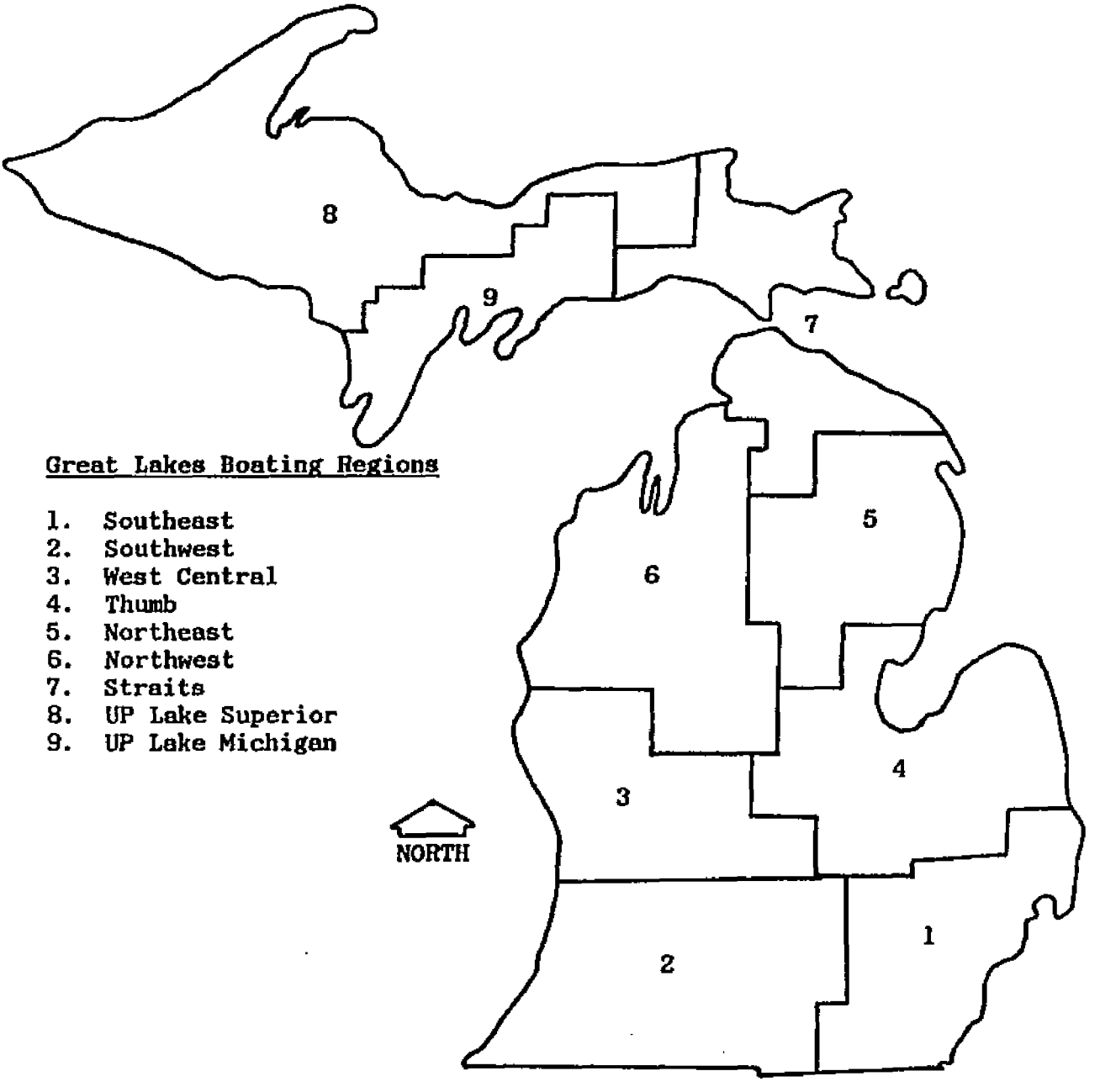

Figure 1. Great Lakes Market-Oriented Recreational Boating Regions (From 1980 Michigan Recreational Boating Survey, Stynes and Safronoff, 1982).

Methods for Assessing Changes in Marinas Between 1978 and 1983

The second objective of this study was to monitor changes in the number of moorings available at marinas serving Michigan's Great Lakes from 1978 to 1983. One obvious method of approaching this objective would involve a comparison of the 1983 inventory with some previous marina inventory. Any previous inventory used in this comparison would need to be verified by some means to insure its reliability. The secondary data used for this comparative analysis was collected from aerial photographs taken between 1977 and 1980. The vast majority (87 percent) of these photographs were shot during 1978 and so this set of imagery will be referred to as the "1978 photo set" in the rest of this dissertation. This section contains a discussion of the methods used in the 1978 marina inventory and the comparison procedures for determining changes in marinas moorings serving Michigan's Great Lakes.

The 1978 Inventory

The 1978 inventory was completed in a similar manner to the 1983 inventory. To locate marina sites, the entire Great Lakes coastline of Michigan was examined on the aerial photographs. Photo interpretion of marinas provided the same information as the 1983 inventory. Moorings, facilities, and marina locations were recorded for each marina.

The aerial photographs used in this inventory were high altitude false color infrared transparencies. They were vertical photographs with an average scale across the image of 1:24000. Color infrared film is sensitive to the near infrared portion of the electromagnetic spectrum which produces a high resolution image (Brew and Neylands,

1980:287). In most situations this film sensitivity results in water having an image signature of black. This is because the infrared portion of the spectrum is absorbed by water rather than reflected. The photo signature of buoys was white specks on a background of black water. The images were interpreted using a 10 power loupe for magnification. The 1978 inventory includes a set of 1978 aerial photographs, USGS map sheets with marina locations identified, and a record of the facilities provided at each location.

Changes in Marinas from 1978 to 1983

Typically, when an investigation involves a comparison of data collected from two time periods, assumptions must be made concerning comparability of the data. This is because the time lag between observations serves not only as a ripening period for the subject of interest, but also, as a development and reflection period for the investigators. Depending on the length of the interim period, measurement instruments can also change resulting in vast changes in reliability or accuracy of the data collected. The investigators also become experienced, having been through the measurements once, so adjustments may improve the second set of measures. When previous data have been collected by other researchers, comparability of observations from two time periods is doubly suspect. Assumptions concerning reliability and accuracy must be made because the chance to verify data by remeasurement of samples has been lost due to changes in the subject of interest over time.

Differences between the observations may be due to changes in measurement instruments, improved expertise, and inaccurate or invalid

measures taken in the original data, rather than true differences in the subject of interest. In this comparative analysis of marinas, the use of aerial photographs as a data source for the two inventories minimized these type of instrument and investigator biases. Aerial photographs from the two time periods allowed for a direct visual comparison of what existed when the photographs were taken. This eliminated the need for any of the comparability assumptions mentioned above.

The comparison of marinas was first done visually. The 1983 and the 1978 images were placed side-by-side on a light table where they were inspected for differences. If a marina was determined to be the same on both photographs, information was taken from the 1978 photograph and recorded on two data sheets, one for 1978 and one for 1983. When changes had occurred, location information was copied from the first code sheet to the 1983 record and then marina facilities were interpreted from the new photograph and recorded. This visual comparison provided a reliability check and was a quick means of data collection when changes had not occurred.

Methods for Assessing Relative Regional Mooring Needs

Planners in their efforts to provide marina facilities for use by a growing number of Great Lakes boaters should employ a systematic approach to assessing mooring needs. Understanding where, who, and how much are important aspects of this assessment process. The first identifies the locations of marinas and areas in which new facilities are required. The second addresses who is using the marina moorings through a segmentation of the state's boaters into marina and non-marina

boaters. Finally, planners must be able to determine the mooring deficiencies in an area to specify the scale of new facilities which might be required. All three of the aspects listed should be considered as part of an ongoing marina needs assessment process.

The third objective of this dissertation is to apply measures of relative regional needs for addressing the first of the three aspects of marina needs assessment. Theoretically, needs for moorings serving the Great Lakes are the difference between available moorings and those boaters who use marina moorings plus those in the population who would want to use a mooring if it were made available at the current price. A relative measure of needs on the other hand can be expressed as a ratio of the moorings available to a surrogate measure of total marina boaters in the population. In applying relative measures of need to local regions of the state, first the number of existing moorings must be inventoried. Then a ratio of moorings to a valid measure of marina boaters is calculated. This ratio measure is also made for a reference area, in this case the state. Using the reference area as a benchmark, the relative needs assessment technique systematically compares the local regions with the state, providing relative regional needs for moorings serving Michigan's Great Lakes. This ratio index is a type of locational quotient much like the one Rooney applied to the origin of professional football players (1974). By dividing the state average by the regional ratio, a measure of the relative needs is obtained. A quotient of 1.0 indicates a region's moorings are comparable to the state average. Those quotients greater than 1.0 indicate the region's ratio of moorings to demand or potential demand is below the state average suggesting that there is an unmet need relative to the state

average. Quotients less than 1.0 indicate moorings to demand ratios greater than the state average.

There are two components of this type of relative needs assessment measure which must be defined. The first is identification of regions used in the assessment. Secondly, meaningful units for measurement of ratio components of mooring supply and demand must be selected. Two previously defined regionalizations are used in this comparative analysis along with five ratio measures of Great Lake boat mooring need.

Regionalizations

It would be helpful for state planning purposes to have a measure of the statewide mooring needs (Waterways Division, MDNR, 1982). It would also be helpful, for development purposes, to know the mooring needs at a particular location. However, the former can not be used for location decisions and the latter is so detailed it would produce a statewide comparative analysis so complex it would be undecipherable (Smith, 1983:3). So, two previously defined intermediate regionalizations were selected for comparison of the needs assessment results.

The first was an aggregation used for analysis of the 1980 Michigan Recreational Boating Survey (Stynes and Safronoff, 1982). The regions are illustrated in Figure 1 (p. 45). These are boating market-oriented regions, formed by grouping counties using origin-destination data from the 1977 boating survey. Criteria used to develop the regions were: 1) that they should reflect Great Lakes boating markets (i.e., minimize out of region boating), 2) that they should be made up of contiguous counties and 3) that they should reflect sub-areas of Michigan's

shoreline (Stynes and Safronoff, 1982:B-1).

The second regionalization used in this analysis was the official Michigan planning regions established by an executive order from the Office of the Governor. These regions were used in analyses of the 1977 Recreational Boating Survey (MDNR, 1979) and the 1979 Michigan Recreation Plan (MDNR, 1979). These regions, established for multiple use planning and development applications, are illustrated in Figure 2.

A comparative analysis of correlations between needs and growth and development measures using these two regionalizations was made to determine the influence of data aggretation on the outcome of need assessments. It was hypothesized that the market-oriented regions were a more appropriate aggregation in that they were defined based on use decisions, one component of the phenomenon being measured. The Michigan planning regions, on the other hand, were developed to isolate areas of similar socioeconomic characteristics. While socioeconomic characteristics are related to recreation opportunities and participation decisions, they are not a direct measure of use. Due to different objectives for defining these regionalizations, correlation measures of mooring needs and growth and developoment measures should be higher for the market-oriented regions.

Michigan Planning Regions

1. Detroit
   A. Wayne County
   B. Oakland/Macomb Counties
   C. Outer Counties
2. Jackson
3. Kalamazoo - Battle Creek
4. Benton Harbor - St. Joseph
5. Flint
6. Lansing
7. Saginaw - Bay City
   A. Central
   B. Thumb
   C. North
8. Grand Rapids
   A. South
   B. North
9. Alpena
10. Traverse Bay
11. Sault St. Marie
12. Escanaba - Marquette - Iron Mt.
13. Houghton - Ironwood
14. Muskegon

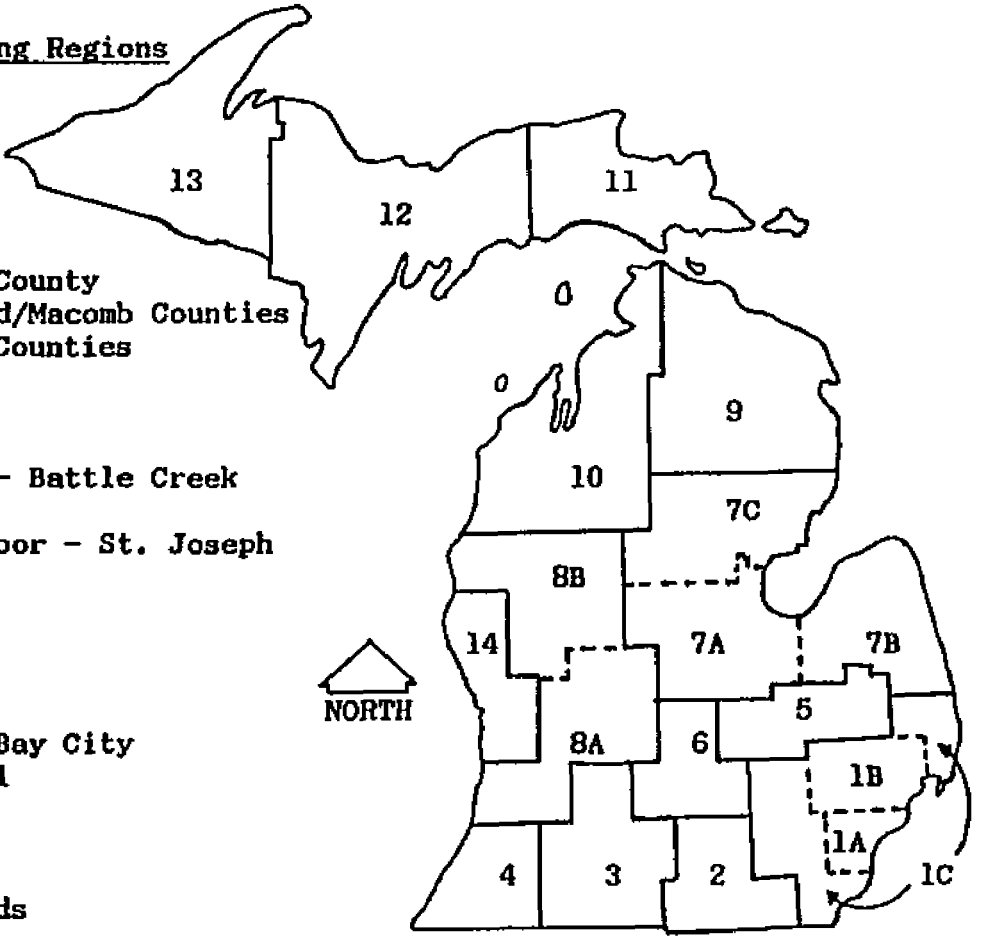

Figure 2. Michigan Planning Regions
(MDNR, Office of Planning Services)

Selected Relative Needs Assessment Measures

Applications of needs assessment measures take the form of multivariate formulas, standards, locational quotients, and discrepancy analyses. The locational quotient measure reflects the focus of this analysis which is on measuring the relative need of marina moorings in areas of the state. Dividing a total number of marina moorings serving Michigan's Great Lakes by a measurement of demand for the state yields an average measure of moorings to demand. Marina moorings (Appendix D) and measures of demand were aggregated using regions discussed in the previous section. Dividing the regional moorings by the regional demand yields a regional ratio measurement of moorings to demand. A mooring needs quotient was then calculated by dividing the relative statewide value by the regional measures. This needs quotient is inverse of a typical ratio measure because it is not measuring the proportion of a total but rather the "difference" between the regional measure and the state average. The needs quotients can be expressed as:

$$N_j = (M / D_i) / (m_j / d_{ij})$$

where: N_j = Needs quotient for region j

M = Marina moorings in the state

D = State demand measure i

m_j = Number of marina moorings in region j

d_{ij} = Demand measure i of region j

Demand measures for the five need indices are discussed in the following sections.

Moorings Per Capita

Per capita measures of recreational facilities are common in the planning literature. Applications of per capita measures take the form of standards, locational quotients, and slight variations of these. In this ratio index, population of regions in thousands was used as the measure of demand (Bureau of the Census, 1985). Dividing a total value of moorings by the population yields a measure of relative size of resource availability. Dividing the state availability by the regional mooring availability provided the relative measure for each region.

Moorings Per Registered Boat

Owners of boats must register craft which are 16 feet in length or greater with the Michigan Department of State. Boats are registered in specific counties which provides a measure of the number of boats in the fleet and the distribution, by county, of the state's boat fleet. The numbers of boats registered in each county on December 31, 1978 and 1983 were obtained from the Michigan Secretary of State's Office (Bureau of Regulation and Licensing Data Center, 1984). Regional registrations were summed from these county boat registrations (Appendix E). A regional mooring per registered boat value was calculated by dividing the number of moorings in each region by the number of registered boats. A relative needs index was then calculated by dividing the state moorings per registered boat value by the regional values.

Moorings Per Great Lakes Boat

Registered boats in Michigan are most heavily used on the state's inland waters (Stynes and Safronoff, 1982:64). To reflect ratios of moorings to boats which are used on the Great Lakes, estimates were made of the number of boats in a region which are likely to be used on the Great Lakes. The proportions of boats which use the Great Lakes statewide were estimated by Stynes and Holecek (1982:64) using the 1977 Michigan Recreational Boating Study data. Boats which are 20 feet in length or less make up the majority of the boating fleet (88.55 percent). Of these boats, it was estimated that 35.16 percent were used on the Great Lakes. Boats larger than 20 feet are much more likely to be used on the Great Lakes. It was estimated that 64.42 percent of this segment is used on the Great Lakes (Appendix F).

These proportions of the small boats and larger boats were used to estimate a Great Lakes boating segment of the boat fleet. The numbers of registered boats 20 feet or smaller, for each county, were multiplied by .3516 and the numbers of larger boats were multiplied by .6442. The sum of these products are estimates of the numbers of Great Lakes boats registered in all the counties which were then aggregated to the regional level. Specifically, this calculation can be expressed as:

$$y_i = o_i * .3516 + n_i * .6442$$

where: y_i = number of Great Lakes boats in county i

o_i = number of craft 20 feet or less in county i

n_i = number of craft greater than 20 feet in length in county i

These calculations were made under the assumption that the proportions of the boats used on the Great Lakes were stable between 1977 and 1983. Another necessary assumption was that the proportions of small and large boats used of the Great Lakes did not vary among the counties. Calculations of the moorings per Great Lakes boat need ratios for each region were similar to per capita quotients calculated above.

Moorings Per Great Lakes Boat Greater Than 20 Feet in Length

To reflect that portion of the Great Lakes boating fleet which must be stored in a wet mooring because they are difficult to transport and launch, registered Great Lakes boats greater than 20 feet in length were used to calculate a mooring need index. The number of Great Lakes boats greater than 20 feet in length was taken from 1978 and 1983 year end boat registration records. The needs quotients were then calculated for moorings per large boat using the equation stated above.

Moorings Per Great Lakes Boat by Destination Region

Origin and destination regions of Great Lakes boat use were estimated for 1978 and 1983 to calculate a relative needs index based on location of boating use. These estimates are based on secondary data sources and several assumptions. The secondary data were: boat registrations by county and size class as of December 31, 1978 and 1983 (Bureau of Regulation and Licensing Data Center), an estimate of the proportion of the recreational boating fleet used on the Great Lakes (Stynes and Holecek, 1982), and the number of boat days[2] generated by

[2] A boat day is defined as any portion of a day where the boat is actually in the water under power or sail (Stynes and Safronoff, 1982).

boaters on the Great Lakes by origin and destination for 1977 and 1980 (Stynes and Holecek, 1981; Stynes and Safronoff, 1982).

Boat registrations and the proportion of the fleet used on the Great Lakes were discussed in previous sections. Distribution of Great Lakes boats for 1978 and 1983, based on region[3] of use, was determined by the number of boat days generated by each region origin and destination during 1977 and 1980 (see Appendix G; Stynes and Holecek, 1981; Stynes and Safronoff, 1982:80). Origin/destination table entries for 1978 were based on responses of boat owners to a 1977 mail questionnaire. Table entries for 1983 origin/destination Great Lakes boat use were based on the 1980 distribution of Great Lakes boat use.

Table entries for 1977 and 1980 distribution of boat use in each region were divided by the total number of Great Lakes boating days generated in each region during the respective year. This produced a proportional distribution of regional Great Lakes boating use. These proportions were then multiplied by the regional total number of registered Great Lakes boats during 1978 and 1983. These calculations were made under the assumptions that: 1) proportions of small and large boats using the Great Lakes remained constant between 1978 and 1983, and 2) an average number of boat days per boat is uniform for boats from a given region. That is to say, these results would vary if a larger proportion of small boats were being used on the Great Lakes in 1983 as in 1978. Or, if there was a significant difference in the average number of days boats were used in one region over the others.

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[3] Regions used in this analysis are market-oriented regions, Figure 1 above, page 45 (Stynes and Safronoff, 1982).

These regional proportions of Great Lakes boats may be stated mathematically as follows:

$$b_{ij} = p_{ij} * b_i$$

where: b_{ij} = Number of Great Lakes boats from region i used in region j

p_{ij} = Proportion of boating activity from region i to region j

b_i = Number of registered Great Lakes boats in region i during 1978 and 1983

A relative measure of needs among regions was then calculated by dividing the state ratio of marina moorings per Great Lakes boat by the regional moorings per Great Lakes boat used in the region.

Evaluation of Mooring Need Indices

The relative mooring need measures were then evaluated by assessing their validity. In conventional usage, validity refers to the extent to which a measure adequately reflects the concept under consideration (Babbie, 1983:117). There are several methods, which fall into three groups, for validating indices. First, there is face validity which refers to the degree to which content of a measure: 1) pertains to the concept being measured, and 2) represents all aspects of the concept (Shaw and Wright, 1967:18). Secondly, construct validity indicates the degree to which a particular measure produces the same conclusions as other measures of the same concept (Carmines and Zeller, 1979:23). Finally, criterion related validity is concerned with testing the performance of a measure relative to some established criterion which is a direct measure of the concept under consideration and is independent of the measure being validated (Babbie, 1983:117). Validity of need

indices used for these analyses were assessed based on construct validity and their face validity. To validate mooring need indices using criterion related validity, criteria which directly measure needs must be available. There are no established standards or criteria available for assessing mooring needs for the Great Lakes. Thus, criteria related validation was excluded from this assessment.

Face Validity of Mooring Need Indices

A particular empirical measure is sure not to reflect all aspects of the concept under consideration. However, if the measure is somehow related to the concept and the measure reflects some aspects of the concept, then it can be said that the empirical measure possesses face validity. Face validity of the mooring need indices were evaluated subjectively based on the definition of mooring needs. The definition used for this assessment was a relative measure of mooring needs. This can be stated as, relative mooring needs are multiplicative values above or below the state average moorings to demand ratio. For example, a mooring needs index value of 2.0 implies that twice as many moorings are needed in a region to bring it up to the state average. Each index was examined as to: 1) its pertinence to the definition of mooring needs and 2) aspects of mooring needs represented in the index.

Construct Validity of Mooring Need Indices

An important element of construct validation is the empirical testing of theoretical concepts through statistical tests (Babbie, 1983:60). It was first determined, through measures of association, whether the need indices were correlated. If the indices were all

measuring some aspect of mooring needs, then there should be some relationship among the results of these measures. It was also determined, empirically, whether regions where indices measured high relative needs in 1978 in fact experienced high relative increases in moorings between 1978 and 1983. McKinney's work in Ohio indicated that marina owners are cognizant of an area's mooring needs when considering growth and development decisions (1979:38). It was hypothesized from his findings that marinas or new moorings would be constructed in areas where there were highest needs; assuming that developers wanted to minimize the risks involved. This theoretical hypothesis was tested by measuring the association between needs measured and subsequent development of moorings in an area. This association can be stated as:

$$Y = f(X)$$

where: Y = growth and development of marina moorings in an area

X = mooring needs of an area (measures of supply and demand)

Mooring needs for an area were specified in previous sections and each was used in this analysis. Thus, empirical hypotheses: $y = f(x_1)$, $y = f(x_2)$, $y = f(x_3)$, $y = f(x_4)$, $y = f(x_5)$ were tested. Using the notion of interchangeability of indices, as discussed by Babbie (1983:61-62), the theoretical hypothesis: $Y = f(X)$, above, was used to test the construct validity of each of the mooring need indices. That is to say, if marina growth and development decisions are a function of needs, then marina growth and development should be empirically related to all empirical indicators of mooring needs.

Marina Growth and Development Index

Marina growth and development was based on measurement of changes in the number of marina moorings between 1978 and 1983. To operationalize marina growth and development into a relative measure, regional measures had to be composed of a relative 1978 baseline measurement and a measurement of the relative changes in numbers of moorings in a region. Relative 1978 baseline measurements were the proportions of total moorings in each region. Relative mooring changes were measured as the proportion in each region of net moorings added to the state between 1978 and 1983 (regional share of change). A marina growth and development ratio index for each region was then calculated by dividing regional proportions of net moorings by the 1978 regional proportions of moorings. This quotient index is expressed as:

$$D_i = (x_i / n) / (X_i / N)$$

where: D_i = growth and development index for region i

x_i = net moorings added to region i between 1978 and 1983

n = net moorings added to the state between 1978 and 1983

X_i = moorings inventoried in region i 1978

N = moorings inventoried in the state 1978

This index reflects changes in moorings relative to a state "average", similar to the need indices. That is to say, if the number of moorings in a region change proportional to the 1978 base proportion for a region then an index value of 1.0 would result. If proportional marina growth and development exceeds the 1978 proportion for a region then a quotient

greater than 1.0 is calculated. A result less than 1.0 has the opposite meaning.

This index is based on: 1) expected growth and development in a region resulting from overall change in the state would maintain the base year proportional mooring distribution and 2) regions with a higher rate of growth and development than the state rate receive a greater proportion of the net development than the regional base proportion. If net mooring changes were distributed at an even rate among regions then the base proportions would not change from the base year to the terminal year. If a region with 10 percent of the state's moorings in 1978 received 20 percent of the net mooring development between 1978 and 1983 then the region experienced a higher growth and development rate than the state, resulting in an index value greater than 1.0. This greater rate of growth and development in a region would imply that marina owners and developers felt that the needs were greater in this area than in other areas of the state.

Spearman Rank Correlation

Due to the nature of the distributions of indices calculated for this study (assumption of normality was not made), ranks of measurements for each region were used to test the association between mooring need indices and the growth and development index. The Spearman rank correlation coefficient was used as the test statistic (Spearman, 1904). It was used to determine if there was a reliable relationship among mooring needs measures and between needs measured during the base year and subsequent development during the study time period.

Summary

The primary focus of this research was on measurement of Great Lake mooring needs in Michigan. One means of assessing mooring needs is to establish relative measures of an existing supply/demand relationship. The three objectives in this study relate to measures of supply (objectives 1 and 2), and using secondary data related to measures of demand to develop relative mooring needs indices (objective 3).

Aerial photographs were used as data sources for supply measures of moorings for 1978 and 1983. Inventories of moorings were used to establish a baseline and to determine changes in the number of moorings available. Photographic procedures were discussed as well as inventory and change detection techniques.

A theoretical foundation of relative need assessment measures is based on the desire of planners and decision makers to compare regions to improve allocation of resources. To make these comparisons, regions must be defined which are meaningful in the sense that they provide the planner with information relative to the activity or resource to be allocated.

Regions used in these analyses are based on the market areas of Great Lakes counties and the political/state resource regions defined by the state's executive branch. Relative measures of mooring needs for regions of the state were developed using various regional statistics. These measures range from a general per capita measure to a specific measure of moorings per Great Lake boat used in a region. Methods for assessing the validity of the need indices were based on subjective evaluation of face validity and empirical tests of hypotheses concerning the relationship of needs and subsequent development of marina moorings.

CHAPTER IV

INVENTORY OF MARINAS SERVING MICHIGAN'S GREAT LAKES: 1983

The general results of the 1983 inventory of marina facilities which serve Michigan's Great Lakes are presented in this chapter. The discussion includes statistics for the distribution of the marinas as well as the facilities available. These results are presented by various regionalizations which are based on political jurisdictions, boater travel behavior (Great Lakes boating markets; Figure 1, p.45), and Great Lake served. The chapter concludes with comments on the effectiveness and limitations of the inventory process used to collect these data.

Marina and Mooring Results

Numbers of marinas and moorings provided are presented in Table 1, for each Great Lake. In 1983, the mean size of a marina in the state was 56 moorings; with Lake Superior having the smallest mean at 25 moorings and Lake Erie having the largest with 87 moorings. Lake Michigan had the greatest number of marinas and was second to Lake St. Clair in the number of moorings provided. Lake Superior had the smallest number of marinas and moorings. Slips accounted for the largest proportion of the moorings for each lake, with the exception of Lake Superior.

Table 1. 1983 Michigan Marina Inventory by Great Lake Served

LAKE	NUMBER OF MARINAS ((% OF TOTAL))	NUMBER OF MOORINGS (% OF LAKE TOTAL) ((% OF STATE TOTAL))				MEAN NUMBER OF MOORINGS
		SLIPS	BROADSIDE	BUOY	TOTAL	
MICHIGAN	234	9994	1265	561	11820	51
		(85)	(11)	(5)	(100)	
	((31))	((27))	((30))	((91))	((28))	
SUPERIOR	37	501	410	5	916	25
		(55)	(45)	(1)	(100)	
	((5))	((1))	((10))	((1))	((2))	
HURON	212	6464	1379	53	7896	37
		(82)	(17)	(1)	(100)	
	((28))	((18))	((33))	((9))	((19))	
ST. CLAIR	198	14334	902	0	15236	77
		(94)	(6)	(0)	(100)	
	((27))	((39))	((21))	((0))	((37))	
ERIE	65	5358	270	0	5628	87
		(95)	(5)	(0)	(100)	
	((9))	((15))	((6))	((0))	((14))	
TOTAL	746	36651	4226	619	41496	56
		(88)	(10)	(1)	(100)	
	((100))	((100))	((100))	((100))	((100))	

Buoy moorings were only incidental, accounting for just over one percent of the total moorings in the state. Lake Michigan had most of the buoys in the state with 91 percent of the state total. These accounted for five percent of Lake Michigan's moorings. Of the nearly 41,500 moorings inventoried, 37 percent, the largest proportion, served Lake St. Clair. Lakes Erie and Superior ranked fourth and fifth respectively in total moorings.

Marinas and moorings by counties in each of the Great Lakes boating regions are presented in Table 2. Regional results are discussed and then the county totals. The Southeast region had by far the most marinas and total moorings with nearly 39 percent and 53 percent of the state totals respectively. The Southeast region also had the largest average number of moorings per marina. For slips and broadside moorings, the Southeast region had the highest proportion of the state total with 56 percent of the slip and 31 percent of the broadside moorings. The only region with no buoy moorings during 1983 was the Southeast region. The UP Lake Superior and Lake Michigan regions differed from the general pattern in that both regions had a high percentage of broadside moorings, with nearly half their moorings in this category. The UP Lake Michigan region had 15 percent buoy moorings, which was the highest proportion of buoys of any of the regions. The West Central region had the greatest number of buoys with 244.

The three counties with the most marinas were all in the Southeast region. The sum of marinas in these counties; St. Clair, Macomb, and Wayne, represented nearly 35 percent of the state total. Chippewa

Table 2. 1983 Michigan Marina Inventory by County and Great Lakes Boating Region

COUNTY	NUMBER OF MARINAS	NUMBER OF MOORINGS				MEAN NUMBER OF MOORINGS
		SLIPS	BROADSIDE	BUOY	TOTAL	
SOUTHEAST REGION						
MACOMB	85	7951	409	0	8360	98
MONROE	32	2810	163	0	2973	93
ST. CLAIR	94	3657	454	0	4111	44
WAYNE	78	6116	289	0	6405	82
SUBTOTAL	289	20534	1315	0	21849	76
SOUTHWEST REGION						
ALLEGAN	18	710	21	0	731	41
BERRIEN	12	1764	52	19	1835	153
VAN BUREN	17	621	90	0	711	42
SUBTOTAL	47	3095	163	19	3277	70
WEST CENTRAL REGION						
MUSKEGON	23	1122	118	193	1433	62
OCEANA	9	171	91	3	265	29
OTTAWA	42	2417	143	48	2608	62
SUBTOTAL	74	3710	352	244	4306	58
THUMB REGION						
ARENAC	10	425	70	0	495	50
BAY	17	1571	63	0	1634	96
HURON	30	883	116	0	999	33
SANILAC	3	187	36	10	233	78
TUSCOLA	4	146	0	0	146	37
SUBTOTAL	64	3212	285	10	3507	55
NORTHEAST REGION						
ALCONA	1	14	0	0	14	14
ALPENA	3	158	25	0	183	61
IOSCO	14	631	189	9	829	59
SUBTOTAL	18	803	214	9	1026	57
NORTHWEST REGION						
ANTRIM	2	68	0	6	74	37
BENZIE	7	204	37	15	256	37
CHARLEVOIX	29	719	109	59	887	31
GR. TRAVERSE	3	175	45	0	220	73
LEELANAU	11	417	50	77	544	49
MANISTEE	20	629	101	0	730	37
MASON	9	342	73	0	415	46
SUBTOTAL	81	2554	415	157	3126	39

Table 2 (cont'd.).

COUNTY	NUMBER OF MARINAS	NUMBER OF MOORINGS				MEAN NUMBER OF MOORINGS
		SLIPS	BROADSIDE	BUOY	TOTAL	
			STRAITS REGION			
CHEBOYGAN	7	215	64	0	279	40
CHIPPEWA	61	808	379	0	1187	19
EMMET	7	381	70	64	515	74
MACKINAC	41	557	293	34	884	22
PRESQUE ISLE	3	92	38	0	130	43
SUBTOTAL	119	2053	844	98	2995	25
			UP LAKE SUPERIOR REGION			
ALGER	2	0	50	5	55	28
BARAGA	4	133	10	0	143	36
GOGEBIC	2	0	52	0	52	26
HOUGHTON	14	161	69	0	230	16
KEWEENAW	6	18	61	0	79	13
LUCE	0	0	0	0	0	0
MARQUETTE	4	114	148	0	262	66
ONTONAGON	2	53	7	0	60	30
SUBTOTAL	34	479	397	5	881	26
			UP LAKE MICHIGAN REGION			
DELTA	16	147	201	32	380	24
MENOMINEE	3	41	37	45	123	41
SCHOOLCRAFT	1	23	3	0	26	26
SUBTOTAL	20	211	241	77	529	26
TOTAL	746	36651	4226	619	41496	56

County, with 61 marinas, ranked fourth in the state.

Macomb County, in the Southeast region, ranked number one in total moorings with over 20 percent of the state total. In fact, there was such a concentration of moorings in the Southeast region that the four counties in the region ranked one through four in total moorings. At the other end of the ranking of the 41 counties with Great Lakes coastline were Schoolcraft, Alcona and Luce Counties, ranking 39, 40, and 41 respectively for total moorings available. Luce County was the only Great Lakes county without a marina serving the Great Lakes during 1983.

Berrien County, in the Southwest region, had by far the largest average capacity with 153 moorings per marina. This was nearly three times the state average and nearly four times the average for the other two counties in the Southwest. Macomb County ranked number two with a mean capacity of 98 moorings. Alcona, Keweenaw and Luce Counties held the last three rankings for the average capacity with 14, 13, and 0 respectively.

For most counties, slips made up the majority of the available moorings. Exceptions to this were found in counties in the UP Lake Superior and Lake Michigan regions where broadside moorings made up from over 50 percent to 100 percent of the moorings. Another deviation from the state norm for mooring type was found in Muskegon County. Marinas in Muskegon County had over 30 percent of the states buoy moorings. These moorings made up 13 percent of Muskegon's total while satewide buoy moorings accounted for only one percent of the state's total mooring capacity. Most counties, 27 out of 41, have no buoy moorings.

Slip Inventory

Slips accounted for the majority of the state's mooring capacity during 1983. These were inventoried in four size classes. Slippage in each size class which served each Great Lake is listed in Table 3. Slips in the 20 to 30 feet size class made up the largest group of slips for the state and for each of the lakes. The slips less than 20 feet in length made up the next largest proportion of slips on each lake. The proportions vary among the lakes for the ranking of the two large size classes. On Lake Superior, slips greater than 40 feet in length ranked third largest with 17 percent of the slippage. On the other lakes, the 30 to 40 feet size class ranked third. Lake St. Clair had more total slips than any other lake with 39 percent of the state total. It had 42 percent of the less than 20 feet size class which was nearly twice as many as any other lake. Lake Michigan had the highest concentration of slips greater than 40 feet in length with 36 percent of the state total.

Slips located in each county are listed by the nine Great Lakes boating regions in Table 4. The Southeast region had over half the total slips in the state. These were distributed among the size classes with most slips in the 20 to 30 feet size class and least in the greater than 40 feet size class. Distribution of slips among size classes in the Southwest deviated from the state distribution in that the largest share of slips was in the less than 20 feet size class and the smallest share was in the 30 to 40 feet size class. The greatest proportion of slips in the UP and Straits regions was also the smaller size class. The UP Lake Superior region deviated from the state distribution by having only 12 percent of the slips in the 30 to 40 feet size class.

Table 3. 1983 Inventory of Slips by Size Class and Great Lake Served

LAKE	NUMBER OF SLIPS % OF SLIPS SERVING LAKE % OF SLIPS IN SIZE CLASS				
	LT 20 FT	20-30 FT	30-40 FT	GT 40 FT	LAKE TOTAL
MICHIGAN	3055	3715	1974	1250	9994
	31	37	20	13	100
	24	26	32	36	27
SUPERIOR	167	186	63	85	501
	33	37	13	17	100
	1	1	1	2	1
HURON	2236	2477	1046	705	6464
	35	38	16	11	100
	18	17	17	20	18
ST. CLAIR	5371	5399	2365	1199	14334
	37	38	16	8	100
	42	38	38	35	39
ERIE	1916	2467	740	235	5358
	36	46	14	4	100
	15	17	12	7	15
TOTAL	12745	14244	6188	3474	36651
	35	39	17	9	100
	100	100	100	100	100

Table 4. 1983 Inventory of Slips by County and Great Lakes Boating Region

COUNTY	NUMBER OF SLIPS				
	LT 20 FT	20-30 FT	30-40 FT	GT 40 FT	TOTAL
			SOUTHEAST REGION		
MACOMB	3279	3046	1174	452	7951
MONROE	1229	1172	298	111	2810
ST. CLAIR	1052	1567	787	251	3657
WAYNE	1778	2541	1066	731	6116
SUBTOTAL	7338	8326	3325	1545	20534
			SOUTHWEST REGION		
ALLEGAN	200	54	127	329	710
BERRIEN	850	492	304	118	1764
VAN BUREN	222	322	11	66	621
SUBTOTAL	1272	868	442	513	3095
			WEST CENTRAL REGION		
MUSKEGON	501	388	130	103	1122
OCEANA	49	48	38	36	171
OTTAWA	327	1121	700	269	2417
SUBTOTAL	877	1557	868	408	3710
			THUMB REGION		
ARENAC	271	120	16	18	425
BAY	188	781	347	255	1571
HURON	492	243	83	65	883
SANILAC	13	98	48	28	187
TUSCOLA	44	96	6	0	146
SUBTOTAL	1008	1338	500	366	3212
			NORTHEAST REGION		
ALCONA	0	0	0	14	14
ALPENA	6	4	63	85	158
IOSCO	319	228	84	0	631
SUBTOTAL	325	232	147	99	803
			NORTHWEST REGION		
ANTRIM	44	12	0	12	68
BENZIE	9	121	48	26	204
CHARLEVOIX	159	217	228	115	719
GR. TRAVERSE	57	107	11	0	175
LEELANAU	26	271	87	33	417
MANISTEE	295	254	39	41	629
MASON	49	182	102	9	342
SUBTOTAL	639	1164	515	236	2554

Table 4 (cont'd.).

COUNTY	NUMBER OF SLIPS				
	LT 20 FT	20-30 FT	30-40 FT	GT 40 FT	TOTAL
			STRAITS REGION		
CHEBOYGAN	48	95	55	17	215
CHIPPEWA	515	212	68	13	808
EMMET	152	62	96	71	381
MACKINAC	321	120	30	86	557
PRESQUE ISLE	12	22	40	18	92
SUBTOTAL	1048	511	289	205	2053
			UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0	0
BARAGA	54	73	6	0	133
GOGEBIC	0	0	0	0	0
HOUGHTON	34	44	31	52	161
KEWEENAW	14	4	0	0	18
LUCE	0	0	0	0	0
MARQUETTE	39	50	16	9	114
ONTONAGON	13	16	4	21	53
SUBTOTAL	154	186	57	82	479
			UP LAKE MICHIGAN REGION		
DELTA	84	43	20	0	147
MENOMINEE	0	8	25	8	41
SCHOOLCRAFT	0	11	0	12	23
SUBTOTAL	84	62	45	20	211
TOTAL	12745	14244	6188	3474	36651

Macomb County, in the Southeast region, had marinas with nearly 22 percent of the state's slips. Over 40 percent, the largest share, of the slips in Macomb County were in the less than 20 feet size class. Marinas located in Allegan County, in the Southwest region, had a large proportion (46 percent) of slips in the greater than 40 feet size class. Most of the slips in the Southwest were in Berrien County with 57 percent of the regional total.

The West Central region ranked second behind the Southeast for total slips, with 10 percent of the state total. Over 65 percent of the region's total was in Ottawa County. The slippage in Oceana County was well distributed among the size classes with 57 percent split equally between the smaller size classes and 43 percent split between the larger size classes. Bay County marinas, in the Thumb region, accounted for nearly 50 percent of the regional total. The Saginaw River mouth is in Bay County which provides excellent opportunities for marina development and boating access at Bay City.

Counties in the northern Lower Peninsula and the UP regions, had marinas with fewer slips and for the most part, marinas tended to be concentrated at a few locations. Within all of the northern regions, marina development was concentrated in just one or two of a region's counties. The distribution of slips among the four size classes in these northern regions was also variable. In general, there seemed to be a higher proportion of the slips in the larger size classes for the northern counties. Yet, there were counties such as Iosco, in the Northeast region, and Delta, in the UP Lake Michigan region, which had no large slips at all.

Marina Facilities

The percentage of marinas inventoried providing various facilities, other than moorings, are presented in this section. These percentages are listed by Great Lake served in Table 5. Lakes St. Clair and Michigan had relatively low percentages of marinas with launching ramps. This may be due to the high concentrations of marinas where only one or

Table 5. 1983 Percent of Great Lake Marinas With Selected Facilities

GREAT LAKE	NUMBER OF MARINAS	LAUNCH RAMP	HAUL OUT	DRY STORAGE		RECREATION FACILITIES
				COVERED	OPEN	
MICHIGAN	234	41	24	33	52	14
SUPERIOR	37	65	19	5	54	0
HURON	212	61	14	32	40	6
ST. CLAIR	198	35	35	34	48	13
ERIE	65	57	32	34	60	5
STATE	746	48	24	33	53	10

two of the several marinas in a group will provide the launch facilities. On the other lakes, single marinas were more dominant and therefore; nearly every marina provided access with a launch ramp. The highest percentages of marinas which had haul out lifts were found on Lakes St. Clair and Erie. For all the lakes, with the exception of Lake Superior, about one third of the marinas provided covered dry storage. On Lake Superior only five percent provided this type of storage. More marinas provided open dry storage space with over 53 percent of the marinas doing so. Lake Huron had the low with only 40 percent of the

marinas providing open dry storage. This was the most frequently provided of the facilities inventoried.

Recreation facilities associated with a marina were the least frequent facilities inventoried. Just under 10 percent of the marinas had additional land based recreation facilities. Lakes Michigan and St. Clair ranked first and second respectively in providing recreation facilities. Lake Superior marinas were collectively ranked last.

Listed in Table 6 are the percentages of marinas providing various facilities by county for each Great Lakes boating region. Facilities offered were extremely variable among the regions and among the counties within the regions. The wide range of numbers of marinas located in a county added to this variability. Counties which had a large number of marinas, yet varied from the state average by more than 20 percent for a given facility, were of particular interest.

Macomb County, in the Southeast region, had 85 marinas, 44 percent of which had haul out facilities. This was nearly twice the state's 24 percent average. Monroe County, also in the Southeast region, had 32 marinas, 69 percent of these had launch ramps. Chippewa County, in the Straits region, had 61 marinas, 72 percent of which provided launch ramps. These three counties had a considerable number of marinas yet still deviated from the state percentage for facilities providing direct boat access. This suggested that although the large number of marinas in these counties were concentrated in high density clusters, there was still a high demand for boating access.

Only 10 percent of the marinas in the state provided land-based recreation facilities. Wayne County, in the Southeast region, had 18

Table 6. 1983 Percent of Marinas With Selected Facilities by County and Great Lakes Boating Region

COUNTY	NUMBER OF MARINAS	LAUNCH RAMP	HAUL OUT	DRY STORAGE		RECREATION FACILITIES
				COVERED	OPEN	
SOUTHEAST REGION						
MACOMB	85	42	44	39	52	7
MONROE	32	69	31	41	66	3
ST. CLAIR	94	31	23	35	41	7
WAYNE	78	37	33	23	49	23
SUBTOTAL	289	40	33	34	49	11
SOUTHWEST REGION						
ALLEGAN	18	0	17	33	50	33
BERRIEN	12	50	50	58	67	8
VAN BUREN	17	35	18	24	65	6
SUBTOTAL	47	26	26	36	60	17
WEST CENTRAL REGION						
MUSKEGON	23	43	26	39	52	9
OCEANA	9	56	11	44	44	0
OTTAWA	42	43	40	36	55	14
SUBTOTAL	74	45	32	38	53	11
THUMB REGION						
ARENAC	10	80	0	30	60	0
BAY	17	65	35	53	76	0
HURON	30	60	17	33	63	3
SANILAC	3	33	33	67	67	33
TUSCOLA	4	50	25	25	50	0
SUBTOTAL	64	63	20	39	66	3
NORTHEAST REGION						
ALCONA	1	100	0	0	100	0
ALPENA	3	100	67	100	100	0
IOSCO	14	57	14	50	71	7
SUBTOTAL	18	67	22	56	78	6
NORTHWEST REGION						
ANTRIM	2	50	0	0	50	0
BENZIE	7	29	14	29	57	14
CHARLEVOIX	29	41	17	24	34	14
GR. TRAVERSE	3	33	0	33	0	0
LEELANAU	11	64	36	27	45	9
MANISTEE	20	50	20	30	65	10
MASON	9	33	11	44	67	11
SUBTOTAL	81	44	19	28	48	11

Table 6 (cont'd.).

COUNTY	NUMBER OF MARINAS	LAUNCH RAMP	HAUL OUT	DRY STORAGE		RECREATION FACILITIES
				COVERED	OPEN	
STRAITS REGION						
CHEBOYGAN	7	71	57	86	86	0
CHIPPEWA	61	72	3	25	69	5
EMMET	7	29	43	57	57	57
MACKINAC	41	54	5	12	27	7
PRESQUE ISLE	3	100	0	67	67	0
SUBTOTAL	119	64	9	27	55	8
UP LAKE SUPERIOR REGION						
ALGER	2	100	50	100	100	0
BARAGA	4	100	0	0	100	0
GOGEBIC	2	50	0	0	0	0
HOUGHTON	14	43	14	29	50	0
KEWEENAW	6	67	0	0	0	0
LUCE	0	0	0	0	0	0
MARQUETTE	4	75	50	50	50	0
ONTONAGON	2	50	50	0	100	0
SUBTOTAL	34	62	18	24	50	0
UP LAKE MICHIGAN REGION						
DELTA	16	63	6	19	56	13
MENOMINEE	3	33	0	33	33	0
SCHOOLCRAFT	1	0	0	0	0	100
SUBTOTAL	20	55	5	20	50	15
TOTAL	746	48	24	33	53	10

marinas with recreation facilities; this amounts to 23 percent of the counties marinas. This was the most marinas in one county which had recreational facilities.

The availability of dry storage adjacent to marina developments also varied widely among the counties. About one third of the marinas in the state provided this type of storage. Most of the variation for both covered and open dry storage were found in counties with only a few marinas. Mackinac County, in the Straits region, had 41 marinas, yet only 12 percent provided covered dry storage facilities.

An inventory of facilities, such as those presented in Table 6, provide an idea of the level of development for a given marina and the clientele or market served by a marina. Most marinas (53 percent) provided open dry storage and nearly half the marinas provided launch ramps. This represented the lowest level of development beyond just providing mooring facilities. This type of marina would serve the owners of smaller to mid-range boats. Covered dry storage represented a higher level of investment and only one-third of the marinas in the state provided such facilities. These covered facilities were mainly in the larger size classes and would suggest a clientele which had a larger investment in equipment than the average boat owner. Haul out equipment associated with a marina suggested handling of larger boats and providing services to this boater group. Having recreation facilities other than the boating activities associated with the marina reflected the highest level of development. In some cases, the marina development was secondary to these recreation developments and was merely providing access to a boating clientele. An example of this would be an extensive campground development with a small marina facility. So, on the one

hand, one can not assume a marina facility with additional recreation development will be a highly developed marina. But, on the other hand, a marina with all the listed facilities, could be considered among the top ten percent of the developed sites in the state.

Limitations of the Inventory

Some of the limitations of the study will be discussed in this section. This discussion is meant to direct users of these data to appropriate, and away from inappropriate, applications. These limitations will be presented in two sections; the first, will cover limitations of the methods and data collected. The second, will discuss limitations resulting from data not collected.

In any project as complex as this, there are bound to be errors which enter during data collection. These can be minimized by controlling the data collection with built-in verification checks. Strict adherence to these procedures was the best insurance against excessive rates of error. Technical errors were controlled by double checking data as they were being entered and by correlation of the photographs taken in 1983 with previous photographs. Although precautions were taken to build these checks into data collection methods, there were two marinas, identified from 1978 photographs, which were not photographed during the 1983 flights. Due to the expense and limited benefit of making special flights to photograph these marinas, there were two alternatives. The first, to assume the marinas were there, as they were in 1978, or second, that they had been closed in the interim. Since the two sites were flown over and the marinas were not

seen during the 1983 flights, it was assumed that these two marinas had been closed.

There was also one marina in the Dearborn area which was impossible to photograph due to conflicts with air traffic from Detroit International Airport. Ground photographs and additional information were collected, but there was no 1983 aerial photograph taken of this marina (number 429).

In coding these data, errors in counts of moorings were held to a minimum by counting each set of moorings twice during the photographic interpretation and then verifying the keypunching. These data were interpreted from aerial photographs and so were subject to interpreter bias. However, most of the interpretation was done by a single interpreter so bias in interpretation will be consistent. The best way to verify slip classifications and broadside moorings for each marina would be with field checks. The time and expense of field checks precluded this from the methodology and subsequently reduced the accuracy of these data. However, the total number of slips inventoried should be very close to the actual figure, due to the nature of the interpretation methods of the 1983 photographic record. There may have been some "marinas" included in the inventory which were commercial fishing docks or some other type of docking not available for recreational boat moorage.

The second area of limitation of this inventory is in the data which was not collected. The two aerial photographic records of the marinas are valuable as a tool for current decisions and future comparisons. However, for making marina development decisions these photographs are lacking essential information, i.e., repair facilities,

fuel availability, pump-out facilities, etc. In addition, the funding agencies for the project have voiced the need for a correlation of marina locations and names and addresses of the marinas (Waterways Division of MDNR, 1983; Michigan Sea Grant, 1983). Other potential users felt that all waterways and inland lake marinas should have been included in these data (Michigan Marina Operators Meeting, 1983).

The definition of a marina serving the Great Lakes was also a limiting factor of this inventory. Included in the definition used were condominium developments which provided mooring facilities to owners of waterfront property. There was no theoretical difference in function from these "condo" developments and the mooring facility a single family property owner might have on a waterfront. There are thousands of single family mooring facilities which were not included in this study but may be important in resolving some recreational boating access questions. Marina resource managers may be interested in all recreational boating access to the Great Lakes; data not collected for this study.

These data provided a baseline on marinas serving Michigan's Great Lakes. However, the limitations discussed in this section are important for making use of these data and for designing future data collection efforts. The data gathered were limited by the photographic methods used and the lack of ground verification. The variables collected did provide both a direct measure of what facilities were available and an indirect indication of the level of development at a specific marina.

Summary

Results and limitations of the 1983 marina inventory were presented in this chapter. The marina and mooring results were presented by

Great Lake served, Great Lakes boating region, and by county. There was a wide diversity in types of marina development at each level of spatial aggregation. The main limitations of these data resulted from restrictions of methods used in collecting these data and from data which were not collected.

The general findings reported in this chapter were that marina moorings serving Michigan's Great Lakes are concentrated in areas of high population. The Southeast region had nearly 39 percent of the state's marinas. The moorings in the state which serve the Great Lakes were dominated by slip moorings and of these the 20 to 30 feet size class made up the largest share.

CHAPTER V

CHANGE IN MARINAS SERVING MICHIGAN'S GREAT LAKES FROM 1978 TO 1983

The focus of this chapter is on the changes which occurred in the marinas serving Michigan's Great Lakes between 1978 and 1983. Examples of these changes include additions made to existing sites, development of new marinas, and the demolition of marinas or portions of marinas. Results are presented for the various regionalizations which were introduced in the previous chapter.

1978 to 1983 Marina Comparison

Numbers of marinas opened and closed during the five year period are presented in this section. The overall change for an area is presented as a percent net change. These results are presented in Table 7 for each of Michigan's Great Lakes. The largest number of marinas were added to serve Lake Michigan while the greatest percent change was on Lake Erie. Lake Huron registered the highest level of marina closures. A comparison of east to west showed that the east coast had more new development and more marinas closed than the west.

The number of marinas for each of the Great Lakes counties by Great Lakes boating region are presented in Table 8. These data indicate that most of the new marinas inventoried were added in the Southeast region of the state. The Northwest region had the largest percent change in

Table 7. Comparison of 1978 and 1983 Marina Inventories by Great Lake

LAKE	NUMBER OF MARINAS		CHANGE		NET CHANGE (%)
	1978	1983	OPENED	CLOSED	
MICHIGAN	213	234	22	1	9.9
SUPERIOR	34	37	3	0	8.8
HURON	204	212	13	5	3.9
ST. CLAIR	189	198	10	1	4.8
ERIE	55	65	12	2	18.1
TOTAL	695	746	60	9	7.3

numbers of marinas. The Straits region and the Upper Peninsula Lake Michigan region had no net change. The highest number of marina closures in the state occurred in the Southeast region.

The forty-one Great Lakes counties all provided some Great Lakes boating access. However, Luce County, in the UP Lake Superior region had only a single facility that did not meet the criteria established for including a site in these inventories. St. Clair County had the greatest number of marinas in both inventories and ranked second to Wayne County for the highest number of new marinas opened. Wayne County also ranked first for having the highest number of marina closings during the five year period. Chippewa County, in the Straits region, was the only county which had a negative net change, by the loss of a single marina. The counties which had the highest percent net change, Sanilac and Benzie Counties, did so because of the small base number inventoried in 1978. The single marina added to Sanilac County resulted in a 50 percent net change. Therefore, in comparing percent net change among the counties, their respective total number of marinas should also be noted.

Table 8. Comparison of 1978 and 1983 Marina Inventories by County and Great Lake Boating Region

COUNTY	NUMBER OF MARINAS		CHANGE		NET CHANGE (%)
	1978	1983	OPENED	CLOSED	
		SOUTHEAST REGION			
MACOMB	82	85	3	0	3.7
MONROE	27	32	5	0	18.5
ST. CLAIR	89	94	6	1	5.6
WAYNE	70	78	11	3	11.4
SUBTOTAL	68	239	25	4	7.8
		SOUTHWEST REGION			
ALLEGAN	14	18	4	0	28.6
BERRIEN	11	12	1	0	9.1
VAN BUREN	16	17	1	0	6.3
SUBTOTAL	41	47	6	0	14.6
		WEST CENTRAL REGION			
MUSKEGON	20	23	3	0	15.0
OCEANA	8	9	1	0	12.5
OTTAWA	42	42	1	1	0
SUBTOTAL	70	74	5	1	7.1
		THUMB REGION			
ARENAC	10	10	1	1	0
BAY	15	17	3	1	13.3
HURON	29	30	1	0	3.5
SANILAC	2	3	1	0	0
TUSCOLA	4	4	0	0	0
SUBTOTAL	60	64	6	2	6.7
		NORTHEAST REGION			
ALCONA	1	1	0	0	0
ALPENA	3	3	0	0	0
IOSCO	12	14	2	0	16.7
SUBTOTAL	16	18	2	0	12.5
		NORTHWEST REGION			
ANTRIM	2	2	0	0	0
BENZIE	5	7	2	0	40.0
CHARLEVOIX	25	29	4	0	16.0
GR. TRAVERSE	3	3	0	0	0
LEELANAU	10	11	1	0	10.0
MANISTEE	18	20	2	0	11.1
MASON	7	9	2	0	28.6
SUBTOTAL	70	81	11	0	15.7

Table 8 (cont'd.).

COUNTY	NUMBER OF MARINAS		CHANGE		NET CHANGE (%)
	1978	1983	OPENED	CLOSED	
			STRAITS REGION		
CHEBOYGAN	7	7	0	0	0
CHIPPEWA	62	61	0	1	-1.6
EMMET	7	7	0	0	0
MACKINAC	40	41	2	1	2.5
PRESQUE ISLE	3	3	0	0	0
SUBTOTAL	119	119	2	2	0
			UP LAKE SUPERIOR REGION		
ALGER	2	2	0	0	0
BARAGA	3	4	1	0	33.3
GOGEBIC	2	2	0	0	0
HOUGHTON	13	14	1	0	7.7
KEWEENAW	5	6	1	0	20.0
LUCE	0	0	0	0	0
MARQUETTE	4	4	0	0	0
ONTONAGON	2	2	0	0	0
SUBTOTAL	31	34	3	0	9.7
			UP LAKE MICHIGAN REGION		
DELTA	16	16	0	0	0
MENOMINEE	3	3	0	0	0
SCHOOLCRAFT	1	1	0	0	0
SUBTOTAL	20	20	0	0	0
TOTAL	695	746	60	9	7.3

Comparison of 1978 and 1983 Slippage

A comparison of slippage inventoried from 1978 and 1983 aerial photographs are presented in this section. Slippage available for each of the five Great Lakes are reported in Table 9. The construction of new slips followed the same trend as that of marina development, with Lake Michigan having the greatest increase and Lake Erie having the highest percent change. Lake St. Clair had the most slippage with nearly 40 percent of the state total. When this large base is considered, the eleven percent change represents a significant increase

Table 9. Comparison of 1978 and 1983 Slip Inventories by Great Lake

LAKE	NUMBER OF SLIPS		NET CHANGE	% CHANGE
	1978	1983		
MICHIGAN	7730	9994	2264	29.3
SUPERIOR	470	501	31	6.6
HURON	5413	6464	1051	19.4
ST. CLAIR	12917	14334	1417	11.0
ERIE	3981	5358	1377	34.6
TOTAL	30511	36651	6140	20.1

in number of new slips. When the spatial distribution of marinas is considered, this table reflects the concentration of marina slippage along the Lake St. Clair shoreline. For example, Lakes St. Clair and Erie have roughly the same amount of shoreline in Michigan, but Lake St. Clair had about four times as many slips in 1978 as Lake Erie and three times the number of slips in 1983.

Numbers of slips and changes during the five year period for each county by Great Lakes boating region are presented in Table 10. The

general geographic pattern of marina development was also evident in the construction of new slips in the state. The greatest increase in slippage was in the Southeast region. The Northwest had a significant increase in total number of slips, ranked second behind the Southeast region. The two Upper Peninsula regions and the Straits region had low numbers of slips added and had small percent changes.

Monroe County exhibited the largest increase in total slips, followed closely by Macomb County. Houghton, Alpena, and Menominee Counties all lost slippage during the five year period. Nearly 25 percent of the Great Lakes counties had no new slips developed between 1978 and 1983.

A comparison of the overall percent change in marinas (7.3%) with the statewide percent change in slippage (20.1%) indicates the proportion of slips which had been added exceeds the proportion of new marinas. This result was due to additional slippage being added to existing facilities. Approximately 25 percent of existing marinas were changed in some way between 1978 and 1983, and the bulk of these changes consisted of the addition of slip mooring spaces. Marinas in the Northwest region nearly doubled the number of slips in the region between the two inventories while the number of marinas only increased by about 16 percent. The number of marinas located in the West Central and UP Lake Superior regions increased by a greater percent than the slip moorings. These were the only two regions where this occurred.

Slip moorings were inventoried in four size classes. A comparison of the numbers of slips in each size class for the two inventories is presented in Appendix H. These are listed by Great Lake served, boating region, and county. In 1978, slips less than 20 feet in length made up

Table 10. Comparison of 1978 and 1983 Slip Inventories by County and Great Lakes Boating Region

COUNTY	NUMBER OF SLIPS		NET CHANGE	% CHANGE
	1978	1983		
		SOUTHEAST REGION		
MACOMB	7009	7951	942	13.4
MONROE	1834	2810	976	53.2
ST. CLAIR	3246	3657	411	12.7
WAYNE	5495	6116	621	11.3
SUBTOTAL	17584	20534	2950	16.8
		SOUTHWEST REGION		
ALLEGAN	661	710	49	7.4
BERRIEN	1294	1764	470	36.3
VAN BUREN	421	621	200	47.5
SUBTOTAL	2376	3095	719	30.3
		WEST CENTRAL REGION		
MUSKEGON	938	1122	184	19.6
OCEANA	158	171	13	8.2
OTTAWA	1937	2417	480	24.8
SUBTOTAL	3033	3710	677	22.3
		THUMB REGION		
ARENAC	285	425	140	49.1
BAY	1294	1571	308	24.4
HURON	882	883	1	0.1
SANILAC	57	187	130	228.1
TUSCOLA	146	146	0	0
SUBTOTAL	2633	3212	579	22.0
		NORTHEAST REGION		
ALCONA	14	14	0	0
ALPENA	170	158	-12	-7.1
IOSCO	394	631	237	60.2
SUBTOTAL	578	803	225	38.9
		NORTHWEST REGION		
ANTRIM	68	68	0	0
BENZIE	97	204	107	110.3
CHARLEVOIX	480	719	239	49.8
GR. TRAVERSE	175	175	0	0
LEELANAU	287	417	130	45.3
MANISTEE	480	629	149	31.0
MASON	133	342	209	157.1
SUBTOTAL	1720	2554	834	48.5

Table 10 (cont'd.).

COUNTY	NUMBER OF SLIPS 1978	NUMBER OF SLIPS 1983	NET CHANGE	% CHANGE
		STRAITS REGION		
CHEBOYGAN	213	215	2	0.9
CHIPPEWA	748	808	60	8.0
EMMET	377	381	4	1.1
MACKINAC	520	557	37	7.1
PRESQUE ISLE	92	92	0	0
SUBTOTAL	1950	2053	103	5.3
		UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0
BARAGA	115	133	18	15.7
GOGEBIC	0	0	0	0
HOUGHTON	177	161	-16	-9.0
KEWEENAW	4	18	14	350.0
LUCE	0	0	0	0
MARQUETTE	114	114	0	0
ONTONAGON	38	53	15	39.5
SUBTOTAL	448	479	31	6.9
		UP LAKE MICHIGAN REGION		
DELTA	119	147	28	23.5
MENOMINEE	47	41	-6	-12.8
SCHOOLCRAFT	23	23	0	0
SUBTOTAL	189	211	22	11.6
TOTAL	30511	36651	6140	20.1

the largest segment of the slips inventoried. In 1983, the largest number of slips were found in the 20 to 30 feet size class. The largest percent change was in the 30 to 40 feet slip size class with a 31.8 percent increase. Of the 6,140 slips added between 1978 and 1983, over 50 percent (3,316) were in the 20 to 30 feet size class. The importance of this shift to larger slips will become evident when moorings are compared to the boat registrations for the same time period. This comparison will be discussed in the following chapter.

Comparison of 1978 and 1983 Broadside Moorings

Comparisons of the broadside moorings inventoried are presented in this section. Broadside mooring was inventoried by length and reported here in available moorings. The number of moorings was calculated by dividing the length of broadside mooring available in feet by 25 feet per mooring space. Overall broadside mooring declined in the state (-8.4%) between 1978 and 1983 with all five of the Great Lakes experiencing a loss. This was likely due to the conversion of broadside mooring space to slip moorings at existing marinas.

Broadside mooring by Great Lake served is presented in Table 11. Lake Michigan had the greatest amount of broadside mooring lost and the highest percent change. Lake Huron had the highest amount of broadside moorings.

The broadside mooring inventoried for each county by Great Lakes boating regions are presented in Table 12. The Straits region was the only region which gained broadside mooring space. The Southeast region lost the most broadside moorings while the Northeast region had the highest percent change.

Table 11. Comparison of 1978 and 1983 Broadside Mooring by Great Lake

GREAT LAKE	NUMBER OF BROADSIDE MOORINGS		NET CHANGE	% CHANGE
	1978	1983		
MICHIGAN	1468	1266	-202	-13.8
SUPERIOR	418	410	-8	-2.0
HURON	1430	1380	-50	-3.5
ST. CLAIR	992	902	-90	-9.0
ERIE	308	270	-38	-12.4
TOTAL	4616	4228	-388	-8.4

Monroe, Houghton and Chippewa Counties gained the most broadside mooring space between 1978 and 1983. There were only 12 counties which gained broadside moorings while 17 counties lost some of this type of mooring. Wayne, Iosco and Ottawa Counties were the counties which lost the most broadside mooring between 1978 and 1983. The gains in this type mooring can be tied to development of new marinas in an area. This is true for Monroe and Houghton Counties at least. Chippewa County had an increase in broadside moorings due to the reduction in the number of slips at some marinas. Those counties which lost broadside moorings did so primarily because of the conversion to slip moorings.

Table 12. Comparison of 1978 and 1983 Broadside Mooring by County and Great Lakes Boating Region

COUNTY	NUMBER OF BROADSIDE MOORINGS 1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	396	409	13	3.3
MONROE	139	163	24	17.3
ST. CLAIR	609	454	-55	-10.8
WAYNE	392	289	-103	-26.3
SUBTOTAL	1425	1304	-121	-8.5
		SOUTHWEST REGION		
ALLEGAN	21	21	0	0
BERRIEN	53	52	-1	-1.9
VAN BUREN	92	90	-2	-2.2
SUBTOTAL	166	163	-3	-1.8
		WEST CENTRAL REGION		
MUSKEGON	141	118	-23	-16.3
OCEANA	100	91	-9	-9.0
OTTAWA	204	143	-61	-29.9
SUBTOTAL	456	363	-93	-20.4
		THUMB REGION		
ARENAC	88	70	-18	-20.5
BAY	90	63	-27	-30.0
HURON	110	116	6	5.5
SANILAC	30	36	6	20.0
TUSCOLA	0	0	0	0
SUBTOTAL	318	285	-33	-10.4
		NORTHEAST REGION		
ALCONA	0	0	0	0
ALPENA	25	25	0	0
IOSCO	278	189	-89	-32.0
SUBTOTAL	303	214	-89	-29.4
		NORTHWEST REGION		
ANTRIM	0	0	0	0
BENZIE	34	37	3	8.8
CHARLEVOIX	96	109	13	13.5
GR. TRAVERSE	45	45	0	0
LEELANAU	61	50	-11	-18.0
MANISTEE	145	101	-44	-30.3
MASON	68	73	5	7.4
SUBTOTAL	449	415	-34	-7.6

Table 12 (cont'd.).

COUNTY	NUMBER OF BROADSIDE MOORINGS 1978	1983	NET CHANGE	% CHANGE
		STRAITS REGION		
CHEBOYGAN	64	64	0	0
CHIPPEWA	358	379	21	5.9
EMMET	85	70	-15	-17.6
MACKINAC	279	293	14	5.0
PRESQUE ISLE	46	38	-8	-17.4
SUBTOTAL	856	868	12	1.4
		UP LAKE SUPERIOR REGION		
ALGER	74	50	-24	32.5
BARAGA	8	10	2	25.0
GOGEBIC	52	52	0	0
HOUGHTON	47	69	22	46.8
KEWEENAW	61	61	0	0
LUCE	0	0	0	0
MARQUETTE	148	148	0	0
ONTONAGON	16	7	-9	-56.3
SUBTOTAL	406	397	-9	-2.2
		UP LAKE MICHIGAN REGION		
DELTA	222	201	-21	-9.5
MENOMINEE	35	37	2	5.7
SCHOOLCRAFT	3	3	0	0
SUBTOTAL	236	217	-19	-8.1
TOTAL	4616	4228	-388	-8.4

Comparison of 1978 and 1983 Buoy Moorings

The final type of mooring inventoried was buoy mooring. Comparison of the inventories of buoys showed that buoys increased by 24.5 percent statewide between 1978 and 1983. Nearly all of these buoys were added to serve Lake Michigan boaters (Table 13). Lake Huron had the highest percent change with an additional 16 buoys added. Lakes St. Clair and Erie did not have any buoy moorings. This is a very different pattern than the slip or broadside mooring development and is likely due to the contrast in the water resources available for marina development.

Table 13. Comparison of 1978 and 1983 Buoy Moorings by Great Lake

GREAT LAKE	NUMBER OF BUOY MOORINGS		NET CHANGE	% CHANGE
	1978	1983		
MICHIGAN	456	561	105	23.0
SUPERIOR	4	5	1	25.0
HURON	37	53	16	43.2
ST. CLAIR	0	0	0	0
ERIE	0	0	0	0
TOTAL	497	619	122	24.5

The western regions have an advantage in that the natural harbors along the Lake Michigan coastline provide safe buoy mooring waters. The eastern regions on the other hand lack the large natural harbors so breakwaters, which do not usually provide ample space for buoys, must be constructed.

The regional and county comparisons, shown in Table 14, clearly illustrate the continued dominance of the marinas located in northern Lake Michigan regions in providing buoy moorings. The West Central

Table 14. Comparison of 1978 and 1983 Buoy Moorings by County and Great Lakes Boating Region

COUNTY	NUMBER OF BUOY MOORINGS 1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	0	0	0	0
MONROE	0	0	0	0
ST. CLAIR	0	0	0	0
WAYNE	0	0	0	0
SUBTOTAL	0	0	0	0
		SOUTHWEST REGION		
ALLEGAN	0	0	0	0
BERRIEN	19	19	0	0
VAN BUREN	0	0	0	0
SUBTOTAL	19	19	0	0
		WEST CENTRAL REGION		
MUSKEGON	119	193	74	62.2
OCEANA	0	3	3	
OTTAWA	48	48	0	0
SUBTOTAL	167	244	77	46.1
		THUMB REGION		
ARENAC	0	0	0	0
BAY	0	0	0	0
HURON	0	0	0	0
SANILAC	10	10	0	0
TUSCOLA	0	0	0	0
SUBTOTAL	10	10	0	0
		NORTHEAST REGION		
ALCONA	0	0	0	0
ALPENA	0	0	0	0
IOSCO	0	9	9	
SUBTOTAL	0	9	9	
		NORTHWEST REGION		
ANTRIM	6	6	0	0
BENZIE	6	15	9	150.0
CHARLEVOIX	54	59	5	9.3
GR. TRAVERSE	0	0	0	0
LEELANAU	63	77	14	22.2
MANISTEE	0	0	0	0
MASON	0	0	0	0
SUBTOTAL	129	157	28	21.7

Table 14 (cont'd.).

COUNTY	NUMBER OF BUOY MOORINGS 1978	1983	NET CHANGE	% CHANGE
		STRAITS REGION		
CHEBOYGAN	0	0	0	0
CHIPPEWA	0	0	0	0
EMMET	64	64	0	0
MACKINAC	27	34	7	25.9
PRESQUE ISLE	0	0	0	0
SUBTOTAL	91	98	7	7.7
		UP LAKE SUPERIOR REGION		
ALGER	4	5	1	25.0
BARAGA	0	0	0	0
GOGEBIC	0	0	0	0
HOUGHTON	0	0	0	0
KEWEENAW	0	0	0	0
LUCE	0	0	0	0
MARQUETTE	0	0	0	0
ONTONAGON	0	0	0	0
SUBTOTAL	4	5	1	25.0
		UP LAKE MICHIGAN REGION		
DELTA	32	32	0	0
MENOMINEE	45	45	0	0
SCHOOLCRAFT	0	0	0	0
SUBTOTAL	77	77	0	0
TOTAL	497	619	122	24.5

region had the greatest increase with an addition of 77 buoys, 74 of which were added in Muskegon County alone. The Southeast region was the only region which did not have any buoy moorings. The marinas in the individual Great Lakes counties showed similar trends, that is, those counties along the northern shores of Lake Michigan had the highest number of buoys added. Over half the Great Lakes counties (26 of 41) had no marinas with buoys, and there were only two counties, Iosco and Oceana which had none in 1978 but buoys had been added by 1983.

Comparison of 1978 and 1983 Marina Facilities

In addition to mooring facilities, information taken from the aerial photographs included launch ramps and haul out facilities, covered and open dry storage, and land based recreational facilities. These are nominal variables and provide location information only. A comparison of these variables for 1978 and 1983 is presented in Appendices I, J, K, L, and M.

Comparisons of these services showed changes in facilities relative to their geographic distribution. There were no drastic changes in any of the services provided. Results of a comparison of the proportions of marinas providing these services for the two time periods inventoried are presented in Table 15. All these proportions decreased from 1978 to 1983 except land based recreation facilities which increased 1.01%.

Table 15. Percent of Great Lakes Marinas Providing Facilities

FACILITIES	1978	1983
LAUNCH RAMP	49.21	47.86
HAUL OUT	24.46	24.26
COVERED STORAGE	34.82	32.71
OPEN STORAGE	55.25	53.08
RECREATION	8.78	9.79

Summary

Summaries of data collected from aerial photographs taken in 1978 and 1983 were presented in this chapter. Comparisons between the inventories were made at three different levels of geographic aggregation: Great Lake served, Great Lake boating region, and county. These summaries and comparisons were presented to provide an initial introduction to these data and to show in a broad sense how marinas which serve the Great Lakes had changed during the five years between 1978 and 1983.

There were 60 new marinas built during this period which provide greater access to Michigan's Great Lakes. Most of these new marinas are located on the east coast of the Lower Peninsula. There were also 9 marinas closed between 1978 and 1983. The new marinas which were added and additions to existing marinas resulted in the addition of 5,874 new moorings in the state. The slip moorings showed a shift from the smaller slips to larger slips. The greater proportion of slips in the state shifted from the less than 20 feet size class to the 20 to 30 feet size class.

CHAPTER VI

ASSESSING RECREATIONAL BOAT MOORING NEEDS

The two preceding chapters contained information about the numbers of marina facilities serving Michigan's Great Lakes in 1983 and the changes in those facilites during the five year period between 1978 and 1983. To assess Great Lakes recreational boat mooring needs, these supply data were combined with measures of Great Lakes recreational boating demand to produce relative mooring need measures for 1978 and 1983. Needs quotients for the two inventory years are presented and correlations among the regional rankings are discussed for two regionalizations. The mooring need indices were evaluated based on face validity and construct valididty. Finally, correlations between regional rankings of mooring needs measures and regional rankings of a measure of mooring growth and development for the two regionalizations were compared.

When secondary demand data sources were available, needs quotients were calculated using the two regionalizations described in Chapter III. The first was based on Great Lakes boating markets. The market-oriented regions were formed by grouping contiguous counties which formed sub-areas of Michigan's shoreline (Stynes and Safronoff, 1982). These regions are illustrated in Figure 1 (p. 45). The other regionalization is that currently used by Michigan state agencies for multiple use

planning and development applications. These regions are illustrated in Figure 2 (p. 52). Results from these two regionalizations were compared subjectively in terms of resulting measures of association between the need indices and the growth and development indices.

1978 and 1983 Mooring Needs Assessment for Great Lakes Boating Regions

Mooring needs were assessed using five measures of boating demand with the market-oriented boating regions. Mooring need quotients were compared to determine differences among the measures and changes in needs over time. A regional comparative analysis was done to determine regional characteristics and to assess differences among needs measures. Correlation among needs measures were determined to see if the measures were associated. If they all are measuring some aspect of mooring needs in a region, then the measures should be correlated.

Relative mooring needs quotients were calculated by dividing state moorings per boating demand ratios by the regional ratios such that:

$$N_j = (M / D_i) / (m_j / d_{ij})$$

where: N_j = Needs quotient for region j

M = State marina moorings

D_i = State demand measure i

m_j = Region j marina moorings

d_{ij} = Demand measure i of region j

Regional ratios of moorings per demand measures are presented in

Appendix N. The resulting quotients do not provide an optimal level of mooring development statewide nor do they provide a means for determining number of mooring deficiencies in a particular area. However, they do provide a means for ranking regional distributions in order to identify: 1) locations of mooring concentrations and 2) regions where there were relative deficits of moorings. A regional need quotient greater than or less than the state average is greater than or less than 1.0 respectively. Measures of mooring demand included population in thousands, number of registered boats, number of registered boats used on the Great Lakes, number of registered boats greater than 20 feet in length used on the Great Lakes, and number of registered boats used on the Great Lakes by region of destination.

Moorings per thousand population provides a quotient which can be compared among regions of the state. Such a measure is useful in assessing relative recreational needs because it does not rely on current participation. It was assumed that the proportion of persons in the population who would like to participate in Great Lakes boating activities requiring a mooring were equally distributed geographically around the state. To satisfy this participation, a ratio of moorings per population would, therefore, also have to be about equal for all the regions. Relative discrepancies from this theoretical distribution of Great Lakes boaters and moorings were measured using a relative needs quotient.

The mooring to number of registered boats needs quotients represent relative measures of mooring needs based on proportional distribution of the registered boating fleet and the proportional distribution of

moorings. It was assumed that the number of total registered boats in a region provided a measure of the distribution of the boating population.

The majority of the registered boats in Michigan's recreational boating fleet are smaller boats used on inland lakes (55.38 percent; Stynes and Holecek, 1982:64). To represent the proportion of boat owners who used Great Lakes boating facilities during 1978 and 1983, the number of boats in the fleet using the Great Lakes was estimated. Using 1977 recreational boating survey results, Stynes and Holecek (1982:64), estimated the proportion of the state's boating fleet which was used on the Great Lakes by boat size class. These proportions (boats 20 feet or less, .3516; boats greater than 20 feet, .6442) were multiplied by the number of registered boats in each county for each boat size class to determine number of Great Lake boats. For the moorings per registered boat used on the Great Lakes quotient, it was assumed that these proportions were the same for each county and did not change between 1978 and 1983.

To develop estimates of demand for recreational boating, many studies conducted in Michigan have divided the boating fleet into two size classes, those 20 feet and under (small boats) and those over 20 feet in length (large boats). Small boats, under 20 feet in length, can most often be accommodated at boat launching ramps while those over 20 feet require moorings. The proportion of the boating fleet over 20 feet in length which used the Great Lakes was employed as a measure of demand for assessing mooring needs during 1978 and 1983. During this period the proportion of large boats in the fleet expanded from 10.39 percent to 12.08 percent. This is an increase of nearly 7,500 boats. It seems that the marina industry decision makers were aware of this shift to

larger boats because the largest share of slips constructed during this period were in the larger size classes.

The final boating demand component of these needs quotients reflects origin/destination decisions and levels of boat registrations given a certain quantity of boating opportunity. The data for the analysis of Great Lakes origin/destination boat use were obtained from earlier studies conducted by the Department of Park and Recreation Resources (PRR), Michigan State University, for the Michigan Sea Grant Program, and for the Secretary of State's Office, (Stynes and Holecek, 1982; Stynes and Safronoff, 1982; and Michigan Secretary of State, 1984). These data provided estimates of the distribution of Great Lakes boat days among each of the nine Great Lakes market-oriented boating regions by origin and destination during 1977 and 1980 (Appendix F). The number of boat days was determined from an average number of days boated and an estimate of the number of Great Lakes boats in the fleet (Stynes and Safronoff, 1982). These estimates were used to predict the distribution of the number of boats used in each Great Lakes boating region for 1978 and 1983.

Distribution of Great Lakes boat use among the Great Lakes market-oriented boating regions during 1978 and 1983 are presented in Table 16. Each cell of this table represents an estimate of the number of boats from a given region which were primarily used in a given destination region. The 1983 distribution of boats is discussed to point out where there were significant shifts in boat use from regions of registration to other regions of use.

During 1983, approximately 18 percent of the boats registered in the Southeast region were primarily used in other regions of the state.

Table 16. 1978 and 1983 Projections of Number of Great Lakes Boats Used In Great Lakes Boating Regions by Origin and Destination Regions

ORIGIN REGIONS	DESTINATION REGIONS 1	2	3	4	5	6	7	8	9	TOTAL BOATS
	NUMBERS OF BOATS 1978									
1 SOUTHEAST	61639	65	556	3012	1309	2062	2717	426	98	71885
2 SOUTHWEST	1098	23175	4393	329	439	4833	2856	439	220	37782
3 WEST CENTRAL	762	997	19120	293	117	1701	997	117	59	24163
4 THUMB	1283	0	244	18020	1833	2382	2077	244	61	26145
5 NORTHEAST	86	0	86	172	5763	258	774	86	86	7311
6 NORTHWEST	0	0	142	0	0	12739	425	0	0	13305
7 STRAITS	196	0	56	56	0	112	5491	0	0	5912
8 UP LAKE SUPERIOR	48	0	0	0	96	143	48	5835	239	6409
9 UP LAKE MICHIGAN	48	0	0	0	0	0	0	238	2048	2334
OUT OF STATE	1086	1552	310	52	0	1034	3103	362	52	7552
TOTAL BOATS	66246	25789	24908	21934	9557	25265	18488	7748	2863	202798
	1983									
1 SOUTHEAST	57397	240	719	4661	666	2157	2903	506	479	69729
2 SOUTHWEST	1292	18792	7047	940	940	3054	2349	235	117	34765
3 WEST CENTRAL	159	902	17500	1008	53	2970	1061	106	318	24076
4 THUMB	1426	32	222	20056	1869	1521	507	0	0	25632
5 NORTHEAST	260	65	0	585	5586	195	455	195	0	7339
6 NORTHWEST	202	0	202	202	0	11434	1379	34	0	13452
7 STRAITS	33	0	0	0	0	33	5645	33	0	5743
8 UP LAKE SUPERIOR	119	0	24	71	0	24	24	5623	119	6003
9 UP LAKE MICHIGAN	0	0	0	0	0	22	67	156	2027	2272
OUT OF STATE	291	1311	2621	73	291	1820	1529	510	0	8446
TOTAL BOATS	61178	21341	28335	27595	9405	23230	15918	7397	3061	197458

The regions which gained most from this export of boat use were the Thumb, the Northwest and the Straits regions. The Southeast region had a net loss of boat use of about 12 percent.

Nearly 46 percent of the boats registered in the Southwest region during 1983 were primarily used in other regions. These exports were generally north to the West Central, Northwest and Straits regions. The Southwest region only gained a small portion of these losses back from other regions; leaving a net loss of 37 percent.

All other boating regions received more boat use from outside of the region than what left the region during 1983. The Thumb region was nearly even with a net gain of only 7.7 percent. The Straits region had the largest net gain with 177 percent more boaters using the region than registered their boats there. In net gain of boating, this represents an additional 10,000 boats using the region. This analysis of Great Lakes boat use, from regions of registration to regions of use, indicated that there were substantial shifts among regions.

A comparison of the need indices, presented in Table 17, showed relative differences among the demand measures. Differences between the population based ratio and the boat registration ratios resulted from the relative importance of boating in a region. For example, the Northeast, Northwest and the U.P. Lake Superior regions were all below 1.0 during 1978 in terms of needs for the population ratio. However, the registered boat ratio and the Great Lakes boat ratio showed a relative need for moorings in these regions. The differences observed using these measures were a result of the relatively high rate of boat ownership in these regions. The results were opposite for the Southeast region where the rate of boat ownership was lower than the state average.

Table 17. 1978 and 1983 Regional Marina Mooring Need Quotients for Michigan Great Lakes Boating Regions

REGION	1978 MOORING NEED QUOTIENTS[a]				
	A	B	C	D	E
SOUTHEAST	0.98	0.67	0.69	0.93	0.88
SOUTHWEST	2.08	2.74	2.69	2.15	0.86
WEST CENTRAL	1.01	1.22	1.21	1.09	0.93
THUMB	1.54	1.63	1.60	1.25	1.14
NORTHEAST	0.65	1.53	1.52	1.29	1.40
NORTHWEST	0.57	1.08	1.06	0.85	1.42
STRAITS	0.15	0.38	0.38	0.29	1.28
UP LAKE SUPERIOR	0.95	1.42	1.36	0.72	1.57
UP LAKE MICHIGAN	0.56	0.84	0.81	0.45	0.92
	1983 MOORING NEED QUOTIENTS				
SOUTHEAST	0.97	0.68	0.70	0.95	0.80
SOUTHWEST	1.96	2.39	2.33	1.74	0.49
WEST CENTRAL	1.05	1.24	1.23	1.12	0.84
THUMB	1.53	1.63	1.60	1.33	1.89
NORTHEAST	0.68	1.60	1.57	1.31	1.39
NORTHWEST	0.52	0.96	0.94	0.74	1.45
STRAITS	0.17	0.43	0.42	0.32	1.06
UP LAKE SUPERIOR	1.06	1.57	1.50	0.73	2.46
UP LAKE MICHIGAN	0.64	0.99	0.94	0.48	1.78

note: Quotients > 1.0 identify regions where mooring needs exceed the state average.

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes
E. Moorings per registered boat used on the Great Lakes by destination

The registered boat ratio and the Great Lakes boat ratio values did not differ a great deal. These two ratios differed however, for some regions, from the ratio based on the large boats used on the Great Lakes. For example, the results for the two U.P. regions indicated that there were relative mooring needs using the registered boat and Great Lakes boat ratios and a surplus of moorings using the larger boats used on the Great Lakes ratio. This difference was due to a relatively large proportional share of small boats registered in these regions.

The final index, based on origins and destinations of Great Lakes boating use, showed that resort regions, or those which imported boat use, had low mooring needs using the other demand ratios but showed a need using this index. Results for Northwest, Straits (1978), and U.P. Lake Michigan (1983) regions were examples of this.

The Southwest region showed the opposite phenomenon. The other indices showed that there was a need for moorings in the Southwest region, but, once the exports of boats to other regions was considered, there was a surplus of moorings in this region. A caution is warranted at this time and will be discussed further in the section on face validity. The shift of boats out of the region indicted by the origin/destination data may be a strong indication of a shortage of slips within the Southwest. This shortage may be forcing boaters to seek moorage in other regions. One the other hand, the export of boats could be an indication of the number of small boats being trailered out of the region. This choice motivation question was beyond the scope of this disseration, but it suggests avenues for future research.

The Thumb region was the only region of the state where all five measures of mooring need indicated that a relative shortage of moorings

existed. This uniformity among these indices for this one region was strong evidence that there was indeed a need for additional moorings in this region.

Change between 1978 and 1983 in the need indices were slight in most regions and for most need ratios. However, there were some noticeable exceptions. The U.P. regions, as well as the Thumb, had a relatively large increase in mooring needs based on their origin/ destination ratios. The Southwest region had a moderate decrease in mooring needs during the period. This decrease in needs was reflected by all the the mooring needs indices. This was due to the large relative number of slips constructed during the five year period.

The correlation matrices for the 1978 and 1983 mooring needs indices are presented in Table 18. These correlations separated the indices into two distinct groups. Results of Spearman rank correlations indicated that the population ratios and the various segments of regional registered boats were correlated while the origin/destination based index was not correlated with the others. Using arguments discussed by Babbie (1983:61) all indicators of mooring needs should be somewhat correlated due to the fact that they should be measuring the same phenomenon. If it is found that one of the indicators is not related, its validity should be questioned. In this case, it could also be argued that the registered boat measures are a direct function of population and that they do not measure mooring needs any better than a raw population ratio. These validity questions are discussed in a section which follows.

Table 18. 1978 and 1983 Correlation Matrices for Michigan Great Lakes Boating Regional Mooring Needs Indices

MOORING NEED INDICES	MOORING NEED INDICES A	B	C	D	E
			1978		
A. POPULATION	1.000	.864	.867	.875	-.438
B. REGISTERED BOATS	.864	1.000	1.000	.917	-.133
C. GREAT LAKES BOATS	.867	1.000	1.000	.728	-.146
D. GREAT LAKES BOATS > 20 FEET	.875	.917	.728	1.000	-.382
E. GREAT LAKES BOATS DESTINATION	-.438	-.133	-.146	-.328	1.000
			1983		
A. POPULATION	1.000	.835	.845	.839	-.169
B. REGISTERED BOATS	.835	1.000	1.000	.836	.005
C. GREAT LAKES BOATS	.845	1.000	1.000	.856	-.021
D. GREAT LAKES BOATS > 20 FEET	.839	.836	.856	1.000	-.367
E. GREAT LAKES BOATS DESTINATION	-.169	.005	-.021	-.367	1.000

note: Critical value of rho = + or -.586 at .05 level of significance

1978 and 1983 Mooring Needs Assessment for Michigan Planning Regions

Mooring needs were assessed using ratios of moorings per population in thousands, registered boats, registered boats used on the Great Lakes, and registered boats used on the Great Lakes greater than 20 feet in length for the Michigan planning regions. The Great Lakes origin/ destination ratio was not used for this regionalization because the secondary data source for boat days by region was not reported using these planning regions. Differences among the four measures were determined through a comparative analysis, and the 1978 results were compared to those in 1983 to determine changes in mooring needs during this period.

The 1978 and 1983 regional mooring need quotients for the planning regions are presented in Table 19. These results indicated that there was no real differences among the needs assessment measures using this regionalization. There were two regions where one of the measures differed slightly from the others. Results of the four measures indicated that the Oakland/Macomb region had relative mooring needs only using the large boats used on the Great Lakes ratio. This result was due to the fact that the region had a higher proportion of large boats registered than the state average. The Alpena region results showed that there were needs using the boat segmentation ratios but not the population ratio. This was due to the high relative proportion of boat ownership in the region.

Table 19. 1978 and 1983 Regional Marina Mooring Need Quotients for Michigan Planning Regions

REGION	1978 MOORING NEED QUOTIENTS[a]			
	A	B	C	D
1. DETROIT	0.96	0.65	0.67	0.94
A. WAYNE CO.	1.58	0.81	0.83	1.04
B. OAKLAND/MACOMB	0.89	0.71	0.75	1.23
C. OUTER COUNTIES	0.41	0.40	0.40	0.49
2. JACKSON	--	--	--	--
3. KALAMAZOO/BATTLE CK	--	--	--	--
4. BENTON HARBOR/ST. JOSEPH	0.57	0.88	0.87	0.58
5. FLINT	--	--	--	--
6. LANSING	--	--	--	--
7. SAGINAW/BAY CITY	0.81	1.01	1.00	0.87
A. CENTRAL	1.43	1.61	1.58	1.29
B. THUMB	0.41	0.37	0.36	0.36
C. NORTH	0.44	0.98	0.98	0.87
8. GRAND RAPIDS	3.18	4.02	3.96	2.90
A. SOUTH	3.44	4.11	4.06	3.70
B. NORTH	2.28	3.73	3.63	1.49
9. ALPENA	0.71	1.67	1.63	1.36
10. TRAVERSE BAY	0.29	0.69	0.68	0.60
11. SAULT ST. MARIE	0.10	0.27	0.27	0.16
12. ESCANABA/MARQUETTE/IRON MT.	0.83	1.16	1.11	0.65
13. HOUGHTON/IRONWOOD	0.70	1.13	1.08	0.57
14. MUSKEGON	0.35	0.43	0.43	0.49

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes

Table 19 (cont'd.).

REGION	1983 MOORING NEED QUOTIENTS[a]			
	A	B	C	D
1. DETROIT	0.95	0.66	0.68	0.94
A. WAYNE CO.	1.58	0.87	0.81	1.04
B. OAKLAND/MACOMB	0.92	0.74	0.81	1.23
C. OUTER COUNTIES	0.41	0.37	0.41	0.49
2. JACKSON	--	--	--	--
3. KALAMAZOO/BATTLE CK	--	--	--	--
4. BENTON HARBOR/ST. JOSEPH	0.49	0.75	0.68	0.58
5. FLINT	--	--	--	--
6. LANSING	--	--	--	--
7. SAGINAW/BAY CITY	0.80	1.00	1.02	0.87
A. CENTRAL	1.42	1.59	1.58	1.29
B. THUMB	0.44	0.38	0.41	0.36
C. NORTH	0.43	0.90	0.97	0.87
8. GRAND RAPIDS	3.06	3.61	3.61	2.90
A. SOUTH	4.01	4.46	4.46	3.70
B. NORTH	1.40	2.10	2.11	1.49
9. ALPENA	0.88	2.01	1.96	1.36
10. TRAVERSE BAY	0.30	0.65	0.68	0.60
11. SAULT ST. MARIE	0.10	0.30	0.27	0.16
12. ESCANABA/MARQUETTE/IRON MT.	0.98	1.38	1.32	0.65
13. HOUGHTON/IRONWOOD	0.74	1.20	1.09	0.57
14. MUSKEGON	0.36	0.43	0.45	0.49

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes

Correlations of the mooring need indices for Michigan planning regions are presented in Table 20. Spearman rank correlations indicated that the need indices were correlated at the .05 level of significance. As discussed for the market-oriented regions, these correlations indicated that the measures were associated and that if mooring needs are a function of boating use in a generalized sense, then mooring needs should be empirically related to every empirical indicator of boating use.

Table 20. 1978 and 1983 Correlation Matrices for Michigan Planning Regions Mooring Needs Indices

MOORING NEED INDICES	MOORING NEED INDICES A	B	C	D
			1978	
A. POPULATION	1.000	.908	.913	.953
B. REGISTERED BOATS	.908	1.000	1.000	.958
C. GREAT LAKES BOATS	.913	1.000	1.000	.964
D. GREAT LAKES BOATS > 20 FEET	.953	.958	.964	1.000
			1983	
A. POPULATION	1.000	.914	.921	.954
B. REGISTERED BOATS	.914	1.000	1.000	.949
C. GREAT LAKES BOATS	.921	1.000	1.000	.956
D. GREAT LAKES BOATS > 20 FEET	.954	.949	.956	1.000

[a] Critical value of rho = + or −.442 at .05 level of significance

Evaluation of Mooring Need Indices

Evaluation of marina mooring needs indices was based on face validity and construct validity of the indices. First, the face validity of each component of the needs indices is discussed. These are then followed by a discussion of the marina growth and development index and how it relates to mooring needs. Finally, construct validity of the indices are assessed using Spearman rank correlations between the various measures of mooring needs and the marina growth and development index.

Face Validity of Mooring Need Indices

For an index to possess face validity, it must first be related to the concept being measured and second must represent some aspect of that which is being measured. Relative Great Lake boat mooring needs in Michigan are the subject of this investigation and were used to subjectively evaluate the face validity of the selected indices. Relative needs for a region were measured as a comparison of regional ratios of supply to demand relative to the state ratio of supply to demand. The state reference ratio was not selected as a desired level of mooring development to demand, it was merely the average of an existing situation. Therefore, to assess the face validity of these needs indices the supply component and the demand components of these measures were evaluated.

Supply Component

The supply component of these needs indices was represented by the 1978 and 1983 inventories of Michigan's Great Lakes marina moorings.

These inventories were comprehensive in that they covered the entire coastline of the state and included various types of wet storage. If these were the only aspects of the supply component which were considered, one could say that these inventories possessed face validity as measures of available Great Lakes mooring. However, there is a geographic phenomenon which may bias these inventories.

The west coast of Michigan has numerous inland lakes which provide sheltered harbors for Great Lakes boaters, i.e., Lake Charlevoix and Spring Lake, and the east coast provides access via riverswhich flow into the lakes. While these inland lakes and rivers provide boating access to the Great Lakes they also provide boating opportunies of their own. However, from the data sources available, it was not possible to assess where the boats were being used. For this study, it was assumed that all boats moored in these inland waters were used on the Great Lakes. Hence, this assumption introduced a bias into measuring supply. The east coast inland moorings serving the Great Lakes were generally on rivers which serve mainly as avenues of access. These rivers can not provide the same opportunities as the inland lakes on the west coast.

Another factor which may bias this analysis was the number of small marinas (less than six moorings) and the number of private home moorings in a region. The moorings not included in the definition of a marina could significantly bias this analysis. There are regions in the state which have a significant number of private moorings at private homes and recreational second homes with access to the Great Lakes. It is known that these are not equally distributed among regions. Since these were not included in the inventory, their impact on the ratio indices is not known.

With these unknown factors in mind, it can still be said that the marina inventories possessed face validity in that they did pertain only to moorings having access to the Great Lakes as the inventories were defined, and they included all the available moorings supplied by "marinas" as opposed to private moorings. Moorings inventoried on inland lakes located on the west coast did provide access to the Great Lakes. However, there was some unknown proportion of boaters using these facilities which chose not to boat on the Great Lakes.

Demand Components

Population

Population was used as an indicator of demand to provide a measurement which was not directly related to boating participation. This is desirable because it includes an indicator of demand independent of the supply which exists in an area. Therefore, those persons in the population who would like to boat on the Great Lakes but who do not because of a lack of facilities are represented in this measurement. However, this assumes that the proportion of the population demanding Great Lakes boat moorings is equally distributed across regions of the state. This line of reasoning leads to the conclusion that nonparticipation is due to a lack of facilities. Beaman, Kim, and Smith (1979), quantified this relationship as a "supply factor".

There are economic and environmental variations among regions of the state that have an impact on distribution of Great Lakes boating demand. For example, there are areas of the state that have numerous inland lakes which provide ample boating opportunities. Boaters living

in these areas are more likely to use these "close to home" resources rather than boat on the Great Lakes. It also seems likely that a higher proportion of the population in the coastal areas of the state would boat on the Great Lakes. A concentration of population in a region does not necessarily mean that there will be a proportional concentration of Great Lakes boaters needing moorings in the region. Concentration of lower income segments of the population in the large urban areas also would lead to a smaller proportion of the regional population that could afford boating as a pastime.

Registered Boats

Registration is required for boats 16 feet and over used in Michigan waters. Boats are registered by county. Registration data were used as an indicator of the demand for Great Lakes moorings. For this indicator, it was assumed that the proportion of boats registered in a region equalled the proportional distribution of those in the regional population needing Great Lakes moorings in the region. It was further assumed that boats are used in the region of registration.

As with the population measure, geographic distribution of water resources influences the distribution of boating on the Great Lakes. Most of the state has abundant inland waters, and; therefore, the state had a substantial inland fleet and a relatively small Great Lakes fleet (Stynes and Safronoff, 1982). This large segment of boats used on inland waters made up most of this measure of demand. To apply this ratio of moorings per registered boat as a measure of demand for Great Lakes moorings, one must assume that those boaters using inland waters that want to boat on the Great Lakes are proportionally distributed

among regions. In addition, those persons in the population wanting a boat to use on the Great Lakes but who are unable to locate a suitable mooring have been excluded from this measure of demand.

This ratio does provide a relative measure of need in regions of the state independent of population concentration. The concentration of boats registered in a region should reflect the need for boating facilities and thus, Great Lake moorings in a region. This is an improvement over the population ratio; however, as noted above, there are still several limiting assumptions which reduce the face validity of this demand measure.

Registered Boats Used On the Great Lakes

The majority of the registered boats in Michigan's boat fleet are boats used on inland waters (59.20 percent; Stynes and Holecek, 1982:64). To exclude these boat owners from the needs assessment, an estimate was made of the number of registered boats in the fleet which were used on the Great Lakes during 1978 and 1983. The proportion of boats in the fleet used on the Great Lakes was estimated from boat owner responses to the 1977 recreational boating survey. Stynes and Holecek (1982:64), used these responses to estimate the proportion of the small and large boats in the fleet which are used on the Great Lakes. Calculation of the regional Great Lakes fleet was made under the assumptions that the proportions of small and large boats using the Great Lakes were the same for all regions and the same from 1977 through 1983. The assumption was also made that the boats registered in the region were also used in the region. The variability in the proportion of large to small boats registered in regions should, therefore,

correspond to the relative demand for Great Lakes moorings. That is to say, the higher the demand for Great Lakes moorings in a region the greater the proportion of larger boats.

Ratios of registered boats used on the Great Lakes included both those using moorings and those using only launch ramps. A large percentage of the smaller boats used on the Great Lakes are not stored at moorings but rather are trailered when not in use. The limiting assumptions and inclusion of smaller craft which do not need mooring reduce the face validity of this ratio measure.

Large Registered Boats Used On the Great Lakes

The ratio of moorings per large boat used on the Great Lakes only includes those craft registered in each region over 20 feet in length which are likely to use the Great Lakes. The assumptions were made that boats registered in a region were used in that region and that the proportion of large boats used on the Great Lakes was constant across regions. The variability in needs among regions was, therefore, derived from the relative differences in the number of large boats registered in the region.

This ratio measure of moorings per large Great Lakes boat isolates a measure of just those boats which will most likely be stored at marina moorings. The most limiting assumption was that the number of registered boats included in this ratio were used in the region of registration. One could argue that the shifts from one region to another would even things out. However, the origin/destination of Great Lakes boating days reported by Stynes and Safronoff (1982:80), suggested

significant shifts among regions. This would reduce the face validity of this ratio measure of mooring demand.

Registered Boats Used on the Great Lakes by Destination

Analysis of Great Lakes boat use, from regions of registration to regions of use for 1978 and 1983, indicated that there were substantial shifts among the market-oriented boating regions. Some regions averaged out as far as gaining from other regions what they had lost in exports. However, there were regions which exported a substantial portion of the registered boats to other regions in the state. In the Southwest region, for example, there was a net export of 37 percent during the 1980 season. This variability suggested that a valid measure of moorings needs should include this redistribution of use among regions.

Assumptions used for making these calculations of boating demand were: 1) that there were no significant changes in the distribution of use from 1977 to 1978 or from 1980 to 1983, 2) that boat days per boat (frequency of use) was uniform within regions of origin, 3) that proportions of small to large boats using the Great Lakes remained constant between 1977 and 1983, 4) that those boaters leaving a region are doing so for reasons other than lack of facilities within their home region, and 5) that owners of registered boats who do not use the Great Lakes moorings were proportionally distributed among the regions. Unfortunately, small craft had to be included in this analysis because there was no means of separating them from the Great Lakes fleet as reported by the secondary data sources (Stynes and Holecek, 1982; Stynes and Safronoff, 1982). This introduced a significant potential bias into this index because the percentage of small boat owners useing moorings

is smaller than for large boat owners. Due to these limiting assumptions and the bias introduced by the smaller boats, the validity of this ratio measure can also be questioned.

Construct Validity of Mooring Need Indices

Mooring need indices were also tested for their construct validity. This evaluation was based on a correlation between rankings of 1978 needs measures and a ranking of the relative growth and development of marina mooring in a region. It was assumed that marina developers and marina owners could somehow select locations for new mooring developments which would minimize their risks, (i.e., where the mooring needs were greatest). Mooring needs indices for 1978, were correlated using the Spearman rank correlation statistic with subsequent development during the next five years. Subsequent development of marina moorings, after 1978, were measured using a marina growth and development index.

Marina Growth and Development Index

The marina mooring growth and development index was calculated to reflect changes in moorings relative to some reference region. The reference region was the state which provided a ratio measure similar to the needs quotients. The regions which experienced development equal to the statewide average scored an index value of 1.0. Values for regions below the state average were less than 1.0, and regions above the state average were greater than 1.0.

Boating Market-Oriented Regions

Relative growth and development of marina moorings for the market-oriented regions of the state are presented in Table 21. The development quotients for the Northwest and Southwest regions indicated

Table 21. 1978 to 1983 Michigan Great Lakes Boating Region Marina Mooring Growth and Development Index and Rank

REGION	1978 MOORINGS	1983 MOORINGS	% CHANGE	DEVELOPMENT QUOTIENT	RANK
SOUTHEAST	19,020	21,849	14.87	0.91	6
SOUTHWEST	2,561	3,277	27.96	1.71	2
WEST CENTRAL	3,645	4,306	18.13	1.11	3
THUMB	2,992	3,507	17.21	1.05	4
NORTHEAST	881	1,026	16.46	1.00	5
NORTHWEST	2,298	3,126	36.03	2.20	1
STRAITS	2,873	2,995	4.25	0.26	7
UP LAKE SUPERIOR	858	881	2.68	0.16	8
UP LAKE MICHIGAN	526	529	0.57	0.03	9
TOTAL	35,654	41,496	16.39		

a concentration of growth in these regions. There was little relative growth in the UP or Straits regions. The remaining regions were very near the state average. Results of these calculations indicated that developers and planners selected the three west coast regions over other areas of the state for development during this period.

Michigan Planning Regions

The growth and development index for the planning regions in the state are presented in Table 22. The distribution of growth of moorings was slightly different than was indicated by the analysis of market-oriented regions. Three of the top five regions are on the west coast; however, the Saginaw/Bay City North and Detroit Outer Counties regions

Table 22. 1978 to 1983 Michigan Planning Regions Marina Mooring Growth and Development Index and Rank

REGION	1978 MOORINGS	1983 MOORINGS	% CHANGE	DEVELOPMENT QUOTIENT	RANK
1. DETROIT	19,020	21,849	14.87	0.91	--
A. WAYNE CO.	5,887	6,405	8.80	0.54	11
B. OAKLAND/MACOMB	7,405	8,360	12.90	0.79	8
C. OUTER COUNTIES	5,728	7,084	23.67	1.44	4
2. JACKSON	--	--	--	--	--
3. KALAMAZOO/BATTLE CK	--	--	--	--	--
4. BENTON HARBOR/ST. JOSEPH	1,879	2,546	35.50	2.17	2
5. FLINT	--	--	--	--	--
6. LANSING	--	--	--	--	--
7. SAGINAW/BAY CITY	3,664	4,336	18.34	1.12	--
A. CENTRAL	1,384	1,634	18.06	1.10	7
B. THUMB	1,235	1,378	11.58	0.71	9
C. NORTH	1,045	1,324	26.70	1.63	3
8. GRAND RAPIDS	883	1,146	29.78	1.82	--
A. SOUTH	682	731	7.18	0.44	12.5
B. NORTH	201	415	106.47	6.50	1
9. ALPENA	624	606	-2.88	-0.18	15
10. TRAVERSE BAY	2,623	3,226	22.99	1.40	5
11. SAULT ST. MARIE	1,932	2,071	7.19	0.44	12.5
12. ESCANABA/MARQUETTE/IRON MT.	866	846	-2.31	-0.14	14
13. HOUGHTON/IRONWOOD	518	564	8.88	0.54	10
14. MUSKEGON	3,645	4,306	18.13	1.11	6
TOTAL	35,654	41,496	16.39		

ranked third and fourth respectively. The five regions with the lowest development quotients were the same as in the market-oriented analysis with only one exception, the Grand Rapids South region, which had a low relative development measure.

Spearman Rank Correlation

Correlation of needs measurements for 1978 with the relative measure of development between 1978 and 1983 were evaluated to test the theoretical concept that the needs quotients measured some aspect of the relative need for moorings. Based on McKinney's work in Ohio (1979), it was assumed that marina owners and developers were aware of mooring needs around the state in 1978 and that they would locate a new marina or expand existing marinas in areas of highest need. A Spearman rank correlation coefficient was used in these analyses.

Boating Market-Oriented Regions

The 1978 needs quotients rankings, the development index ranking, and the Spearman rank coefficients are presented in in Table 23. The needs quotient, based on moorings per registered boat greater than 20 feet used on the Great Lakes (column D), was the only one which was correlated to the development index at the .05 level of significance. The need quotient rankings in column D for each of the regions were similar to the development index rankings, as suggested by the correlation coefficient, with only one exception. The Northwest region had the highest relative development during the five year period, but this region was ranked sixth out of the nine regions in 1978 in terms of mooring needs. The Northwest is a resort area which provides mooring

Table 23. Spearman Rank Correlations Between 1978 Michigan Great Lakes Boating Region Mooring Needs Quotients and Marina Mooring Growth and Development Index

REGION	NEEDS QUOTIENTS RANKINGS[a]					DEVELOPMENT INDEX RANKING
	A	B	C	D	E	
SOUTHEAST	4	8	8	5	8	6
SOUTHWEST	1	1	1	1	9	2
WEST CENTRAL	3	5	5	4	6	3
THUMB	2	2	2	3	5	4
NORTHEAST	6	3	3	2	3	5
NORTHWEST	7	6	6	6	2	1
STRAITS	9	9	9	9	4	7
UP LAKE SUPERIOR	5	4	4	7	1	8
UP LAKE MICHIGAN	8	7	7	8	7	9
SPEARMAN RANK COEFFICIENT	.500	.450	.450	.633*	-.083	

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes
E. Moorings per active registered boat used on Great Lakes by destination region

* Significant at .05 level using critical value of rho = .586.

facilities for part-time residents and visitors from outside the region. Assessment of mooring needs for a region of this type should take into account this influx of boats from other regions.

The origin/destination measure of Great Lakes boating use (column E) does account for these movements of boats into a region. Needs ranking for the Northwest region for 1978, using the origin/destination ratio, is similar to the ranking for the development index. In fact, five of the nine regions are similar (+ or - 2) for the origin/destination needs index and the development index. The Southwest and the U.P. Lake Superior regions had opposite results for these two indices. The growth and development index ranking was high for the Southwest region while the needs index for the origin/destination ratio ranking was low. The U.P. Lake Superior origin/destination index was ranked highest and the development index for this region was ranked second to the lowest.

Results of these correlations indicated that the needs coefficient for 1978 that was based on moorings per registered Great Lakes boat over 20 feet did correlate with subsequent development of moorings during the following five years. Thus, there was empirical support for the hypothesized relationship between Great Lakes mooring needs and the subsequent development of moorings in areas of highest need, as well as evidence that this mooring needs index possessed construct validity.

Michigan Planning Regions

Correlations of the planning region 1978 needs rankings and the development ranking are presented in Table 24. Spearman rank correlation coefficients indicated that there were no significant correlations

Table 24. Spearman Rank Correlations Between 1978 Michigan Planning Regions Mooring Needs Quotients and Marina Mooring Growth and Development Index

REGION	NEEDS QUOTIENTS RANKINGS[a]				DEVELOPMENT INDEX RANKINGS
	A	B	C	D	
1. DETROIT	—	—	—	—	—
A. WAYNE CO.	3	9	9	6	11
B. OAKLAND/MACOMB	5	10	10	5	8
C. OUTER COUNTIES	11.5	13	13	12	4
2. JACKSON	—	—	—	—	—
3. KALAMAZOO/BATTLE CK	—	—	—	—	—
4. BENTON HARBOR/ST. JOSEPH	9	8	8	8	2
5. FLINT	—	—	—	—	—
6. LANSING	—	—	—	—	—
7. SAGINAW/BAY CITY	—	—	—	—	—
A. CENTRAL	4	4	4	3	7
B. THUMB	11.5	14	14	14	9
C. NORTH	10	7	7	7	3
8. GRAND RAPIDS	—	—	—	—	—
A. SOUTH	1	1	1	1	12.5
B. NORTH	2	2	2	2	1
9. ALPENA	7	3	3	4	15
10. TRAVERSE BAY	14	11	11	10	5
11. SAULT ST. MARIE	15	15	15	15	12.5
12. ESCANABA/MARQUETTE/IRON MT.	6	5	5	10	14
13. HOUGHTON/IRONWOOD	8	6	6	10	10
14. MUSKEGON	13	12	12	13	6
SPEARMAN RANK COEFFICIENT*	-.143	-.127	-.127	.036	

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes
E. Moorings per active registered boat used on Great Lakes by destination

* No coefficients significant at .05 level; critical value of rho = .442

at the .05 level of significance. Grand Rapids North and the Sault St. Marie regions were the only two regions which had similar rankings for the need indices and the development index.

These results indicated, in the case of the planning regions, that there was no correlation between where the mooring needs existed in 1978 and subsequent mooring development. Thus, there was no empirical evidence to support the hypothesized relationship between mooring needs and the subsequent development of marinas and moorings. These correlation results introduced a dilemma into the analysis. They provided evidence that the mooring need indices did not possess construct validity. However, it has already been noted that the ratio of moorings per large Great Lakes boat for the boating market-oriented regionalization was correlated with the growth and development index. Factors which contributed to the difference in results of these two regionalizations are discussed in the following section.

Comparison of Regionalizations

Correlations of the mooring need indices with the growth and development index showed that the regionalizations of the state had an impact on the results of these correlations. It can be argued that valid measures of mooring needs would produce valid results given any form of regionalization. However, the Michigan planning regions and the four selected needs indices provide an example where this is not the case. The same number of moorings were used to determine needs, but, population and registered boats in the state differed for the two regionalizations. Four of the Michigan planning regions are land locked which were removed from the analysis. These regions were excluded

because there were obviously no needs for Great Lake moorings in these land locked regions. This removed a substantial portion of the population and registered boating fleet from the analysis.

The Michigan planning regions were developed with regard to political and socioeconomic concerns and not where the boaters were or where they wanted to boat on the Great Lakes. Effects of this can be illustrated by the fact that the nearest Great Lakes counties to the Grand Rapids region, are in the Muskegon region. The Great Lakes market-oriented regions avoid this by aggregating counties to maximize within-region boating use. Also, all the counties in the state are included in one of the market-oriented regions. From this comparison, it was determined that the Michigan planning regions were unsuited to the analysis of Great Lake mooring needs.

This analysis illustrates the impact of interregional participation on assessment of needs. The market oriented regionalization minimized the effect of participation outside of the regions. However, if a regionalization is not market oriented, and most are not, then these origin/destination factors should be considered in assessing needs.

Summary

Relative measures of mooring needs were calculated by dividing state moorings to boating demand ratios by regional ratios. Resulting quotients provided relative measures of where mooring deficits most likely existed and where potential mooring surpluses might be found. Indicators of demand for recreational boat moorings on the Great Lakes which were used included: 1) population, 2) total registered boating fleet, 3) number of boats registered which are used on the Great Lakes,

4) number of boats registered over 20 feet in length which are used on the Great Lakes, and 5) number of active boats in the fleet used on the Great Lakes by destination of use.

Each of these relative measures of needs for Great Lakes recreational boat moorings are related to only certain aspects of the true needs for moorings. Needs based on population provide an indication of regions with a population which does not currently participate in boating as frequently as it might if more opportunities in the way of mooring facilities were provided. Using the number of registered boats to assess mooring needs reflects the distribution of the boating population, this has the potential advantage of excluding from the measure those persons who would have no interest in boating. There were two segments within the boating population which were used in these needs assessment measures, Great Lakes boaters and Great Lakes boaters owning boats over 20 feet. These measures focus the needs assessment more specifically on those persons in the boating population most likely interested in using Great Lakes moorings. Since the focus here was on Gtreat Lakes mooring needs, this specificity represents a step toward a more relevant measure of needs. The final needs measure, based on the destination of Great Lakes boat use, reflects needs in terms of where people go to boat, not where they registered their boats. These measures of relative mooring needs each reflected different aspects of need, and it was expected that there would be differences among the results. Yet, there were many consistencies among the measures reflected by the correlations among the need indices.

Boating Market-Oriented Regions

The Great Lakes mooring needs measures were most consistent for the Southeast and Thumb regions. The needs values for the Southeast region were all near 1.0 or about equal to the state's standard for each of the measures. This consistency is because a large proportion of the state total for each demand measure was concentrated in the Southeast region. The Thumb region showed a need for moorings relative to other regions using all measures of need.

The most striking contrast among the measures was between the measure of moorings per Great Lakes boat by destination and the other measures of need for the Southwest region (Table 23:128). The quotients for Great Lakes use by destination ranked the Southwest region as having the lowest need among the regions. For all other measures of need, the Southwest region was ranked highest. The Southwest has the highest proportion of people who want to boat, and, if the assumption is made that they will boat within the region, then the Southwest should have the highest demand. When the destination of boating is considered, an entirely different picture emerges due to the high proportion of the boaters leaving the region to go boating. This case illustrates that, by using several measures to assess needs, a broader understanding of the needs concept can be derived. However, care must be taken in the interpretation of results since, as in this case, no one single, simple measure of needs is likely to yield consistent and accurate assessments of needs.

Michigan Planning Regions

Only four of the five needs measures were applied to the planning regions. There were no data available on the distribution of Great Lakes boat use by origin and destination for the Michigan planning regions. The needs measures were consistent in their ranking of the Grand Rapids South and North sub-regions as having the highest needs relative to other regions in the state. The Saginaw/Bay City Central sub-region was also ranked high by all the needs measures. The mooring per population measure ranked Wayne County high due to the large population concentrated in that small area. However, when only the boating population was the focus, Wayne County dropped to near or below the state average. There were no dramatic changes in distribution of needs between 1978 and 1983 among the planning regions of the state. This was consistent with other market-oriented regional findings.

Validity of Needs Measures

Face validity of the supply component of the needs ratios indicated that an inventory of the moorings serving the Great Lakes did possess face validity as a measure of the supply of moorings. The demand components of the needs ratios varied as to their face validity. The population ratio measures indicated relative importance of boating in the region but were limited in assessing the relative mooring needs. The large proportion of the boating fleet used on inland lakes reduced the face validity of the registered boat needs ratios. Similarly, a large proportion of the Great Lakes boat fleet is made up of small trailerable boats which do not need moorings. This limits the face validity of the

Great Lakes boats needs ratios. The mooringa per large boat used on the Great Lakes seems to be a valid measure of mooring demand, but the accuracy of this measure is limited since boats were being used outside their region of origin while variable numbers of boats were entering the region as well. The validity of the origin/destination based index measure was limited because: 1) the small boats used on the Great Lakes were included in this measure, 2) the average number of boat days for a given origin region was not likely constant across all destination regions, 3) the underlying data were extrapolated since secondary data collection periods did not coincide with the time frame of this study 4) the proportion of the boat owners who did leave a region due to lack of facilities in the region was not known, and 5) the proportions of small and large boats using the Great Lakes is likely not uniform statewide.

Construct validity of the needs ratios was assessed under the assumption that developers and owners of marinas had a sense of where mooring needs were concentrated. The needs measured by the ratios of supply and demand for 1978 were correlated with subsequent development during the next five year period. The large Great Lakes boat ratio was the only needs quotient which correlated with the development index using the market-oriented regions.

Correlation analysis of the need quotients and the growth and development index was also used to compare the two regionalizations. Correlations of the needs assessment measures differed between the two regionalizations. No significant correlations were measured for the Michigan planning regions. For the Great Lakes market-oriented regions, the correlation with the ratio of moorings per large boat used on the Great Lakes was significant at the .05 level.

CHAPTER VII

CONCLUSIONS AND DISCUSSION

General Findings

General findings of this research indicated that: 1) marina moorings are concentrated in the areas of the state which have high population, 2) there were significant changes in the "supply" of moorings between 1978 and 1983 (over a 16 percent increase), and 3) development of marina moorings between 1978 and 1983 was correlated with measures of needs for moorings in Michigan's Great Lakes boating regions. The needs ratio based on registered boats greater than 20 feet in length used on the Great Lakes was the only ratio determined to be valid through a subjective face validity analysis and an empirical construct validity analysis. Based on this analysis, the Southwest region had the highest relative Great Lakes mooring needs. Finally, the Michigan regions based on geographical/political boundaries were determined to be unsuited to Great Lakes mooring needs assessment if "demand" measurements are limited to within region participation.

1983 Inventory

Results from the 1983 marina inventory provided a general distribution of the marinas serving the Great Lakes and key characteristics of the moorings and facilities provided. The marinas are generally concen-

trated in natural harbors and in areas of high population density. The Southeast region contains the majority of Michigan's marinas and moorings with 38 percent of the state's marinas and 53 percent of its moorings. The 20 to 30 feet slip was the most common available. Very small marinas dominated the inventory of the northern regions while large marinas accounted for the bulk of the moorings in the southern regions.

This inventory detailed the location of all Michigan marinas serving the Great Lakes and the number of moorings they provided. In addition to the moorings, the aerial photographs of the marinas provided an accurate and complete record of what existed at each marina. At some point in the future, additional analyses could be conducted using the photographic record from 1983 since the photographs accurately reflect existing physical conditions at the time the photographs were taken.

1978 to 1983 Comparisons

During the five year study period, the Great Lakes marina industry added 60 new units and lost nine. The net gain from this new development and the addition of moorings to existing sites was 5,874 new moorings. There was also a significant shift in the size of moorings provided. The 20 to 30 feet slip replaced the less than 20 feet slip as the most common slip size class. This shift could be in response to observed changes in the recreational boating fleet toward larger boats.

Assessing Great Lakes Marina Mooring Needs

Great Lakes mooring needs indices were developed and evaluated to assess relative regional mooring needs in the state. Needs indices were

based on ratio measures of moorings per population, registered boats, registered boats used on the Great Lakes, boats over 20 feet used on the Great Lakes, and destinations of Great Lakes boat use. All of the needs indices were significantly correlated (= .05) with each other with the exception of the destination of Great Lakes boat use ratios. The large number of registered boats in the state and the abundant boating resources in the state leads to a high correlation of the population and registered boats measures. The two ratios which were based on the Great Lakes boats and large Great Lakes boats segmentations should and were correlated with the distribution of registered boats. Due to projected shifts in boat use among the Great Lakes market-oriented regions, the destination of Great Lakes boat use index was not correlated with the other needs indices. This measure of boating demand provided an indication of the distribution of boat use in the state; however, the validity of this measure is limited due to the assumptions made necessary by the available secondary data sources.

Based on face validity of the components of the need ratios, the supply component of the measures, number of Great Lakes moorings, did possess face validity. The demand components of the need ratios; population, size class groupings of registered boats, and destination of boat use, had varying degrees of face validity. Criteria for assessing face validity of needs measures involved judging whether or not the assumptions which were needed to apply the measures were realistic. The ratios of moorings per large boat used on the Great Lakes had the least limiting assumptions.

Construct validity of the need indices was assessed using the correlation between 1978 needs and mooring growth and development which

took place between 1978 and 1983. The growth and development index was based on the percent change of moorings during the five year study period. It was assumed that managers and developers were aware of the location of mooring needs and that a valid needs measure in 1978 would be correlated with subsequent mooring development. The ratio of moorings per large boat used on the Great Lakes for the market-oriented regions was the only needs index correlated to the development index at the .05 level of significance.

Study Limitations

Remote Sensing

There were several limitations to the remote sensing techniques used in collection of the marina inventories for these analyses. First, there were no field checks conducted to confirm and calibrate interpretation of either the 1978 or the 1983 photo series. Field checks were not made because measurements taken from the photographs were calibrated using images of objects of a known size. This limitation may have resulted in misclassification of slip moorings into the wrong size class. Or, it may have resulted in miscalculation of the number of broadside moorings available in the state. However, it was felt the significance of the resulting error did not merit the time and expense of field checks.

The second limitation was in the quantification of the marina service facilities provided. The quantification of these variables could greatly improve the estimation of Great Lakes boating access. One means of access to Great Lakes boating is the use of launch ramps. One

of the limiting factors to launch ramp use is the availability of parking. This would have been one means of quantifying availability of non-moored boat use of the Great Lakes. For some of the sites inventoried, including a measure of the available parking could have been possible. However, counting parking spaces would have been difficult to impossible for many of the marina photographs. Parking areas for marinas in many instances are ill-defined with capacities fluctuating depending on number of boats in dry storage, etc. Other facilities which could not be quantified due to the nature of the data collection technique were dry storage facilities and recreational facilities. Storage facilities could not be quantified because the number of boats which can be stored in a dry storage facility depends on size of boats and technology employed (i.e., dry stack facilities can accommodate smaller size boats by stacking them in multilevel structures on land, and are essentially equal to in water moorings). Facilities also could be provided indoors which would not be imaged on the photographs. The dry storage facilities are of particular interest in terms of increasing access to the water.

Dry stack storage technology has improved considerably in the past few years while the development of additional wet moorings has become increasingly more difficult in terms of expense and regulation. These together are making dry stack storage marinas more appealing to both the marina suppliers and boaters. There was no means for determining the availability of dry storage capacities from the data collection methods used and the information gathered in this study. As dry storage becomes a major factor in providing access to Great Lakes boating, a broader range of inventory techniques will have to be employed.

In addition to these dry storage access sites, there were a large proportion of the private and small public access sites which were excluded from this inventory. This was a result of two factors: 1) the fact that the type of management a marina was under (e.g., private or public) could not be determined from the aerial photographs and 2) the definition of a marina developed for this study derived from the funding agencies' objectives. The main objectives of the MDNR Divisions which funded this study, was to locate and inventory marina slips which provided recreational boating access to Michigan's Great Lakes. Marinas with fewer than six moorings and those marinas which did not directly serve the Great Lakes were not included. Limitations of these objectives resulted in only measuring a portion of the boating access available to boaters. No estimate was made as to what portion of the access was excluded or what changes may have occurred in the other access opportunities.

Boat Registrations

There were limitations to the boat registration data which presented some problems for these analyses. First, unused boats in the registered fleet were counted and used in the analysis. The proportion of boats in the fleet which are not used fluctuates in a cycle. The reason for this cycle is that previous to 1977, all boat registrations expired simultaneously every three years regardless of when boats were registered. This was changed during 1977 to a system in which the registration period lasts from the date of registration to the end of the third year. Since the largest proportion of registrations, which expire all at once, are those boats in the pre-1977 group, a cyclical

peak in the number of registered boats occurs. Since the years of registrations used in this analysis, 1978 and 1983, happened to be peak registration years (Figure 3), it was assumed that the number of boats which were registered was equal to the number of boats in the fleet. If the registration numbers used had not been coincident within the registration cycle a correction factor to estimate the unused proportion of the registered fleet would have been necessary.

Figure 3. Michigan Boat Registrations on December 31, for 1977 to 1984 (Bureau of Regulation and Licensing Data Center, 1984)

Another problem with the registration data is that boats are registered in either the region of residence of the boat owner or the region in which the boat is used and stored. For this analysis, it was assumed that boats were registered in the region of residence of the

boat owner. Since some of the boats were actually registered in regions where they were stored and used, the regional demand ratios used in the needs assessments are distorted. The magnitude of the resulting distortion is not known.

Mooring Needs Assessment

Limitations to the needs indices involve assumptions which were needed to apply the measures. The most limiting assumption for the index based on large Great Lakes boats was that the boats were primarily being used in the region of registration. This assumption was not appropriate for the Michigan planning regions because these regions were not based on boating resource locations or where boaters live. The market-oriented regions, on the other hand, were derived with the objective of minimizing out of region Great Lakes boat use.

The Great Lakes boating destination based index eliminated the need for the assumption that boats registered in a region were used in the region. However, there were some limiting assumptions needed to apply the destination measures. These assumptions were that: 1) distribution of Great Lakes boating use did not change from 1977 to 1978 or from 1980 to 1983, 2) boat days per boat were uniform within each origin region and boat size class, 3) proportion of small to large boats using the Great Lakes remained constant between 1977 and 1983, 4) boaters who leave a region to go boating do so for reasons other than the lack of facilities in their home region, and 5) owners of registered boats, included in this measure, who do not use Great Lakes moorings were proportionally distributed among the regions. These assumptions seem quite limiting for this measure; however, the analysis provided a means

for assessing variation in origin/destination boating use among the Great Lakes boating regions. It was felt that this was helpful in assessing mooring needs because the objective of minimizing out of region use, to establish these regions, was not uniformly successful.

Implications of the Results

1983 Inventory

The 1983 aerial photographic inventory of marinas serving Michigan's Great Lakes provided marina planning agencies with an accurate record of what marina facilities were available during the 1983 boating season. These photographs should represent a baseline of development from which any future development can be monitored and measured. Planning decisions regarding new marinas or expansion of existing facilities can now be made with near complete knowledge of what existed in 1983.

When new marina permit applications are considered or existing permits are reviewed for new development, aerial photographs should be used to verify existing facilities and determine existing conditions to assess possible impacts of new development. This photographic assessment should not replace field inspections, but rather, should supplement information collected from on site visits.

An important aspect of the 1983 inventory is the documentation of what boating access was available in specific areas. The 1983 inventory provides a point from which to measure development of boating access in the future. These data, collected at set intervals, could provide a basis for measurement of the rate of change in mooring development.

Shifts in Marina Supply

The changes in marina supply which were measured between 1978 and 1983 showed several shifts in the development of the marina industry. These changes included a shift to a larger proportion of slips in the 20 to 30 feet size class and fewer broadside moorings being offered. The relative growth and development index showed that there were Great Lakes boating regions which grew at a faster rate than the state average.

The 1978 inventory revealed that the slips in the less than 20 feet size classification made up the largest proportion of the moorings available (38.94 percent of slips). The largest proportion of moorings in the 1983 inventory was in the 20 to 30 feet size classification (38.86 percent of slips). This shift could indicate a change in the boating market being served by marinas having access to the Great Lakes. A trend toward larger slips may indicate a higher value being placed on waterfront moorings, because of the higher price for larger slips. Or this trend could indicate an increase in the proportion of larger size boats using marina moorings. In fact, boat registration data showed that there had been an increase in the proportion of boats registered in the larger size classifications. If waterfront moorings are increasing in price, the smaller boats may be getting priced out of the marina market and must find alternatives to wet moorings at marinas, such as dry stack storage.

Another indication that waterfront access has become more valued during this study period is the shift from broadside moorings to slip moorings. There was a net loss of 8.4 percent of the broadside moorings

statewide during the five year study period. Conversion of the broadside mooring to slips was the primary reason for this loss. Slips are much more expensive to develop than are broadside moorings; however, they are a much more efficient use of available waterfront.

The regional growth and development index was a measure of development relative to the rest of the state. The western portion of the Lower Peninsula was the location of the greatest relative growth during the study period. The Northwest and Southwest regions had the highest gains statewide with the West Central region experiencing moderate gains in moorings.

Mooring Needs Assessment

Mooring needs indices for this study were selected to represent the range from a general index (population) to a specific index (boat use on the Great Lakes by destination). Theoretically, the more specific the needs index the more closely the true needs of the Great Lakes boating fleet would be measured. Criteria for evaluating the validity of the mooring needs indices were: 1) a subjective judgement of the assumptions made for each index, 2) correlations among the needs indices, and 3) correlations between the needs indices and the mooring growth and development index. This evaluation indicated that the needs index based on large boats used on the Great Lakes was valid. Contrary to theoretical expectations, the most specific of the indices, boating destinations, was not. Possible explanations for these results can be found in the needs measures themselves and in Great Lakes boating use.

First, the low correlation between the growth and development index and the boating destination index was likely due to the assumptions

made. The assumptions made for the specific destination index may have been too restrictive for this to be a valid measure of boating demand. But, on the other hand, the low correlation between the growth and development index and the boating destination index may indicate that marina owners and developers did not consider the migration of boaters among regions when making marina location decisions. At the level of analysis that was conducted for this study, it would appear the former is the case; there were just too many unrealistic assumptions made to make accurate projections of destination of boat use.

The Northwest region was the only region which exhibited a low correlation between rankings of the large boats used on the Great Lakes index and the growth and development index. It is likely that the moorings development was high in the region because this region was growing rapidly as a resort area. Boat owners from outside the region may have been using and storing their boats in this region. This use of a region would not be reflected in the index of large boats used on the Great Lakes, but it would be evident in the index of Great Lakes boating destinations; and in fact it was.

The Southwest and West Central regions had high relative development during this period and a high relative need based on the index of large boats used on the Great Lakes. However, the destination based needs index ranking for these two regions ranked them low in terms of need. The discrepancy here might be explained by out of state boaters who use and store their boats in the Southwest and West Central regions. Although the practice is illegal, out of state boaters could use and store their boats in these regions but do not register their boats in Michigan. The extent of this practice is not known but it

could have an affect on the demand for moorings in these regions.

The final result to be explained is the rankings of the Straits and UP Lake Superior regions. For these regions, the development index and the index of large boats used on the Great Lakes rankings were low. However, the needs index based on Great Lakes destination was high. This difference might be explained by the transient nature of boating in these areas. Use of the area by owners of small trailered boats and by boaters cruising Lake Superior or the northern ends of Lakes Huron and Michigan reduces the need for a high proportion of moorings. This type of cruising generates a large number of boat days, the secondary data source unit of measure, from a relatively small number of boats. So, the high ranking of these regions based on the boating destination needs index seems to be unjustified.

There are many other realities, other than mooring needs, in selecting a location for mooring development. These must also be taken into account before development decisions are considered. A partial list of these considerations would be: 1) the difficulty in securing construction and operation permits, 2) the availability of land, 3) competition from existing or proposed marinas, and 4) return on investment.

Further Research Needs

This research documented changes in marinas serving Michigan's Great Lakes and investigated the relationship between changes in marina growth and development (supply) and the estimated changes in boat use (demand) from 1978 to 1983. Future marina inventories could provide information on the rate of change in various regions. If boating use

data were collected during the same time period as the marina growth data, a more accurate correlation could be made between relative regional mooring needs and Great Lakes mooring development.

Information needs to be collected on the management and ownership arrangements of the marinas inventoried. This information should be collected through the state permit to operate process. This analysis could provide information as to which sectors of the marina industry (private clubs or coops, commercial for rent or sale, or public facilities) are growth sectors or which are on the decline. It is possible that the new marinas developed are mostly new condominium developments which provide boating access to resident owners or provide moorings which the boat owners purchase out right. This information is important in assessing economic impacts of marinas in an area.

In addition to the management information, service information should also to be collected during the state permit process. Information on the services provided at a marina would allow for the analysis of dry stack storage capacities as well as other services provided. In the near future, dry stack storage may make up large proportion of the total boat storage opportunities replacing the demand for in water slips. To date, there have been no data collected for the Michigan marina industry on this emerging technology.

Future research should also be directed toward the shifts in the type of moorings being offered. This analysis could provide an indication of shifts in the relative value of waterfront access and the importance of dry stack storage facilities. The goal of this line of research would be to identify the forces behind these shifts in order to better assess what the future may hold.

The data which are collected on boating activities, origins and destinations, and boat storage should be coordinated with future marina studies. If these efforts were coordinated, data collected could be analyzed without the need for many of the crude extrapolations which were made in this investigation to apply the available secondary data.

Additional types of studies could also focus on marinas in Michigan. These could include gravity models or other types of locational models and socioeconomic or psychographic segmentation of boaters to determine; who is going where to boat and if they will need a mooring when they get there? Several types of data should be collected from boaters on their boating activities. Registration data should include the owner's place of residence as well as where the boat is used and stored. Data regarding the boater's choice of mooring location should also be collected. Why do boaters moor their boats at a specific location, is it because they enjoy the boating resources available? Are the resources closer to home too crowded or unavailable? Is it because their friends all have their boats at a specific marina? In collecting these data interstate boating should not be overlooked. This research could lead to a broader understanding of the relationship between the supply of moorings serving the Great Lakes and the demand for recreational boating in Michigan.

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APPENDIX A

UPSTREAM LIMIT ON MAJOR MICHIGAN RIVERS FOR MARINA INVENTORIES

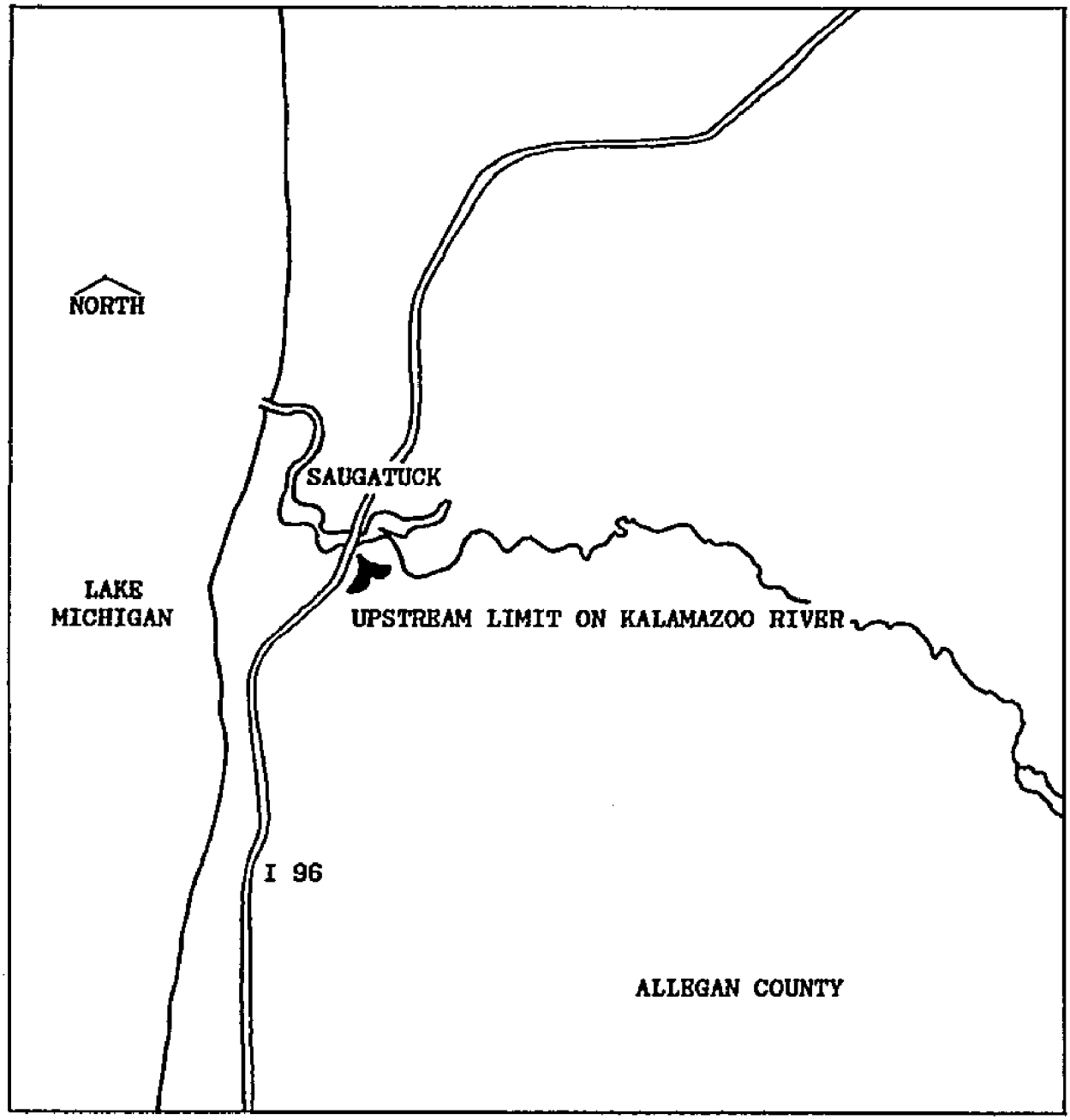

Figure 4. Upstream limit on Kalamazoo River, Allegan County, Michigan

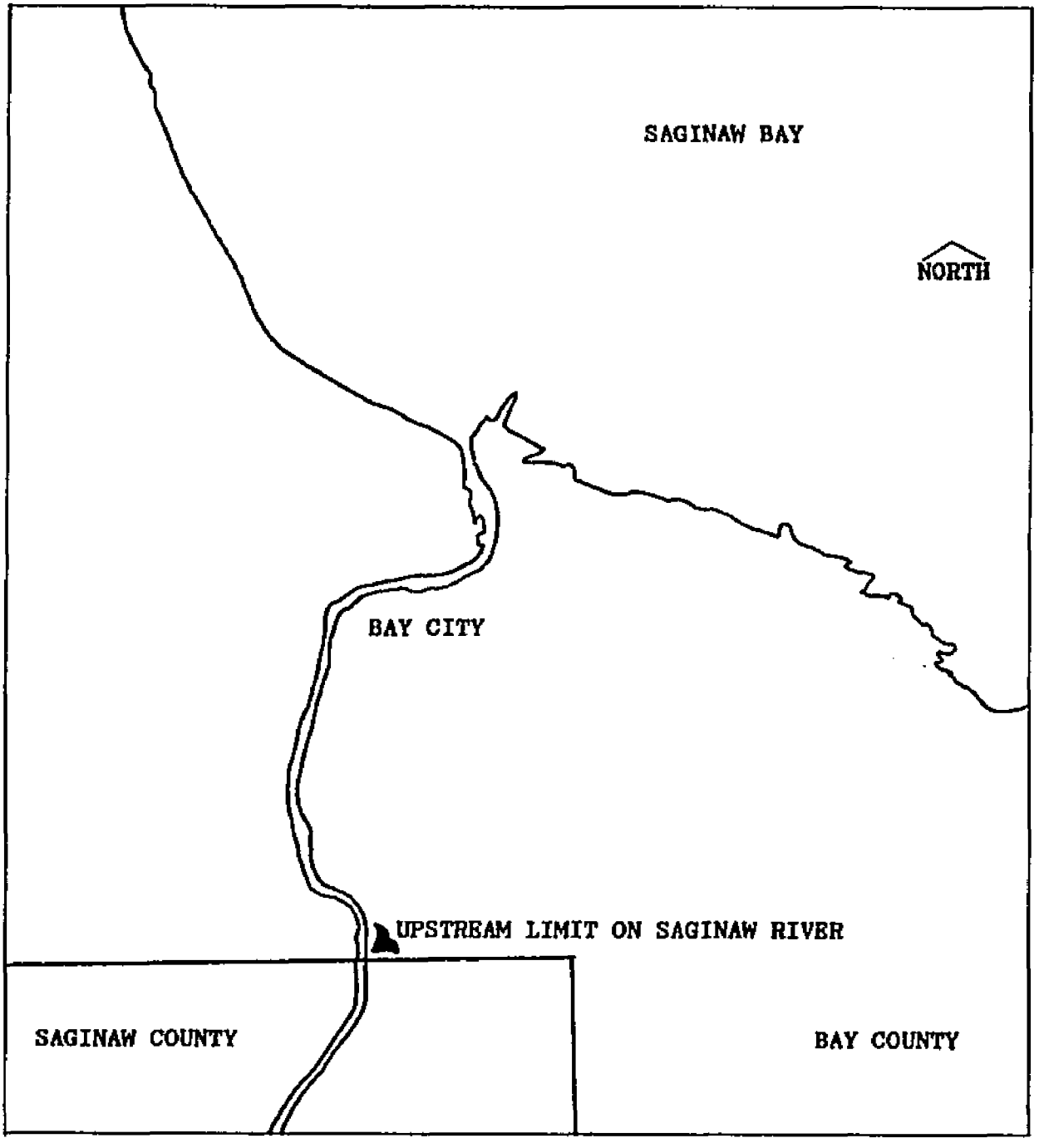

Figure 5. Upstream limit on Saginaw River, Bay County, Michigan

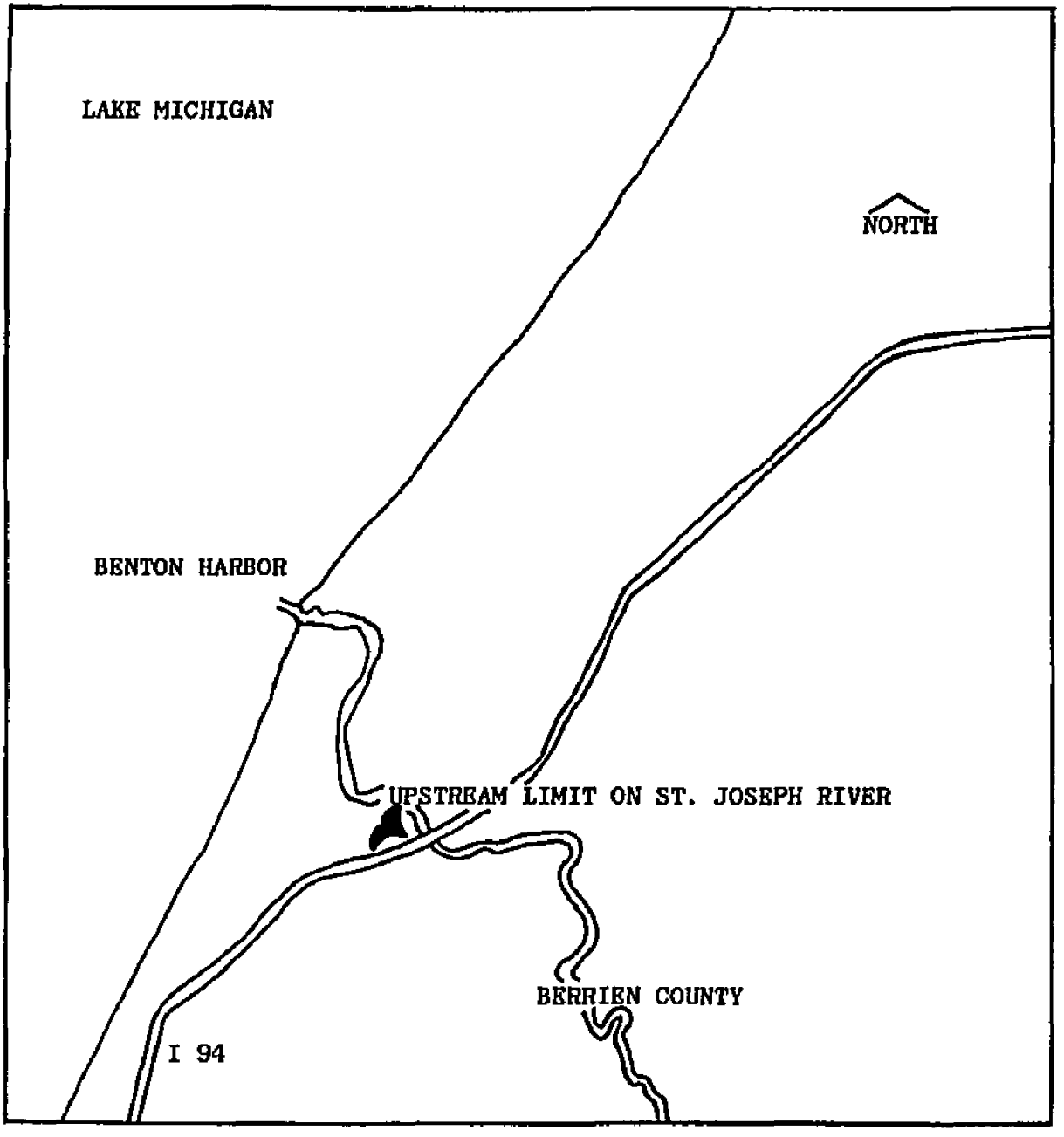

Figure 6. Upstream limit on St. Joseph River, Berrien County, Michigan

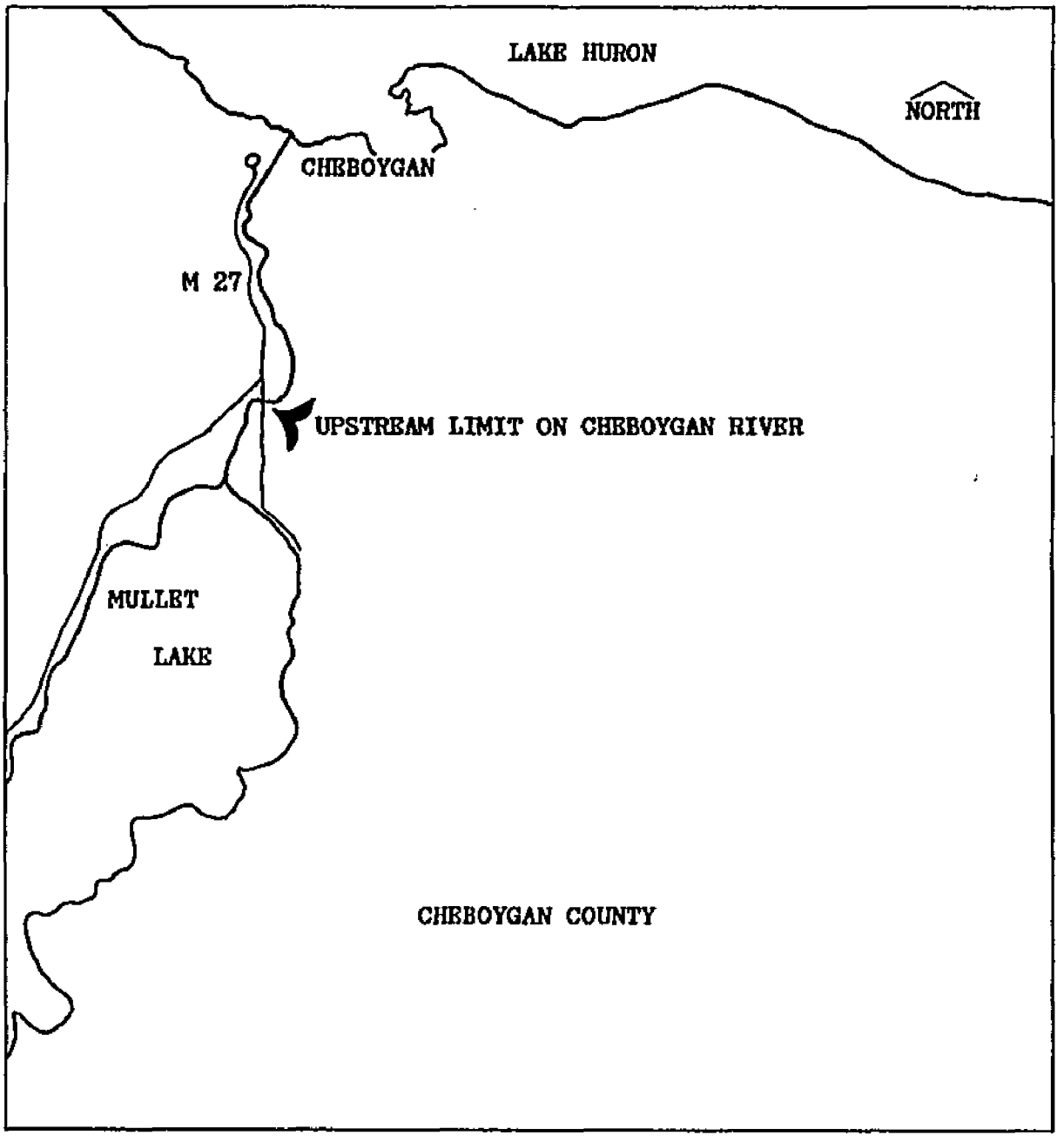

Figure 7. Upstream limit on Cheboygan River, Cheboygan County, Michigan

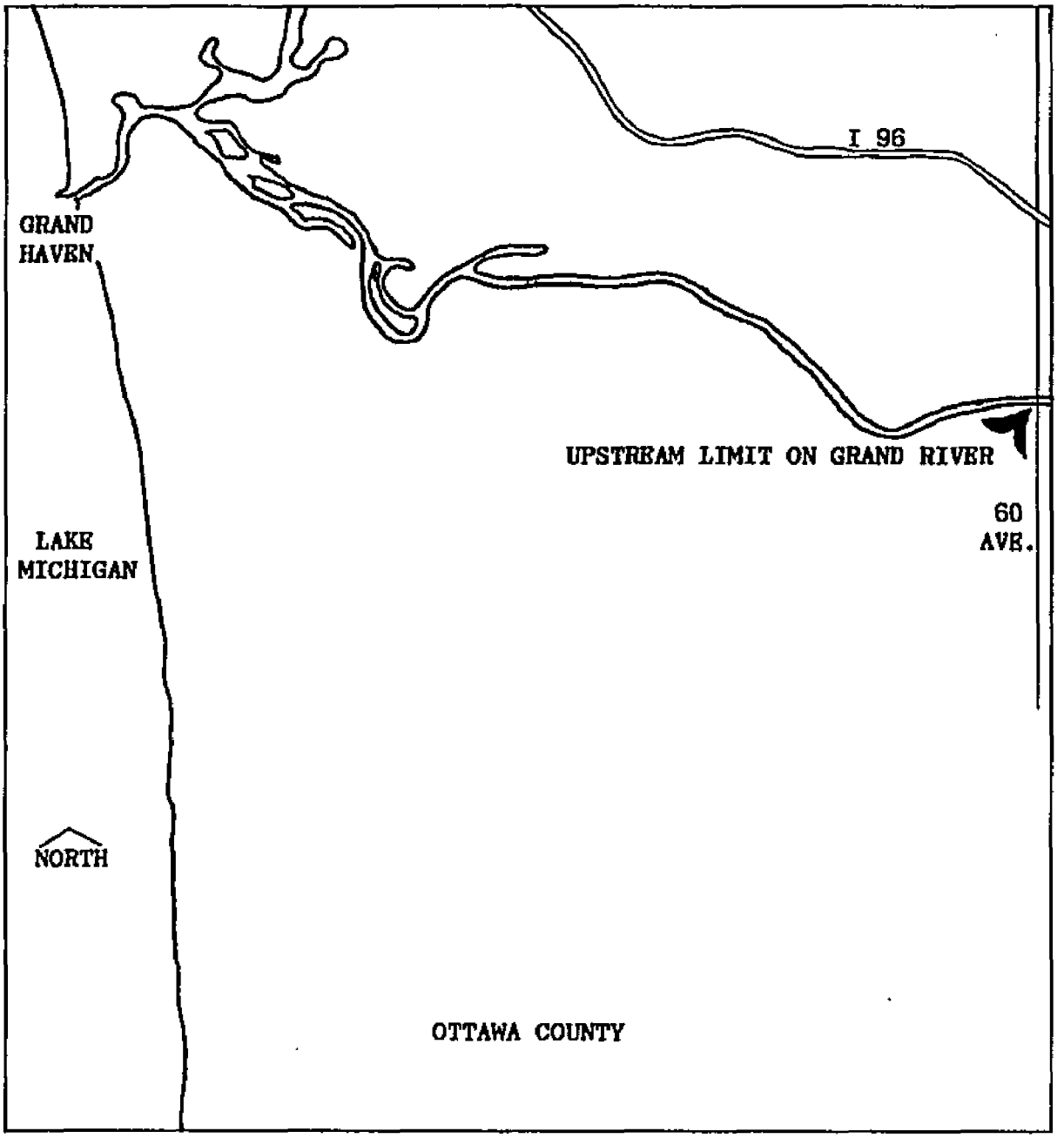

Figure 8. Upstream limit on Grand River, Ottawa County, Michigan

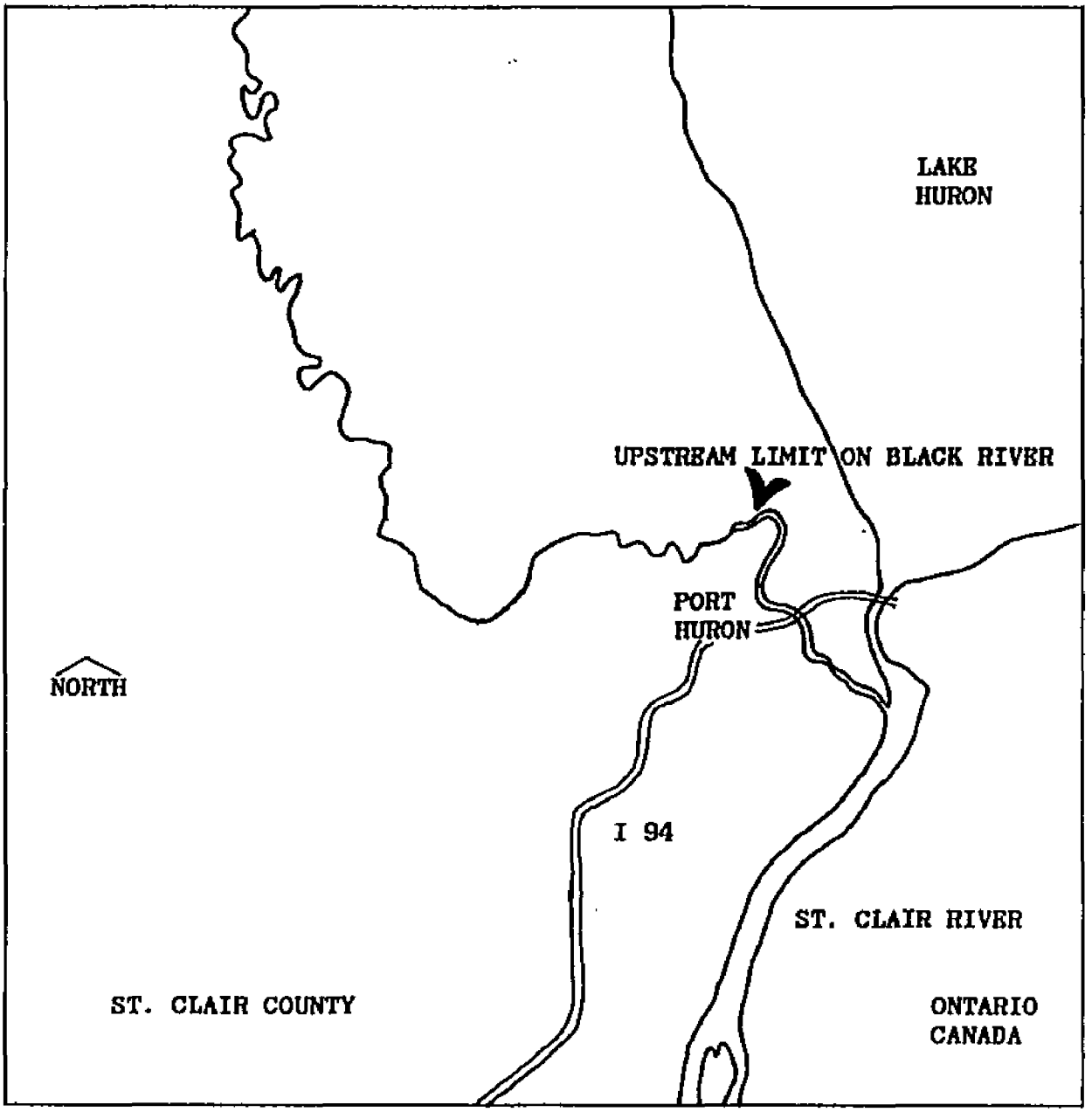

Figure 9. Upstream limit on Black River, St. Clair County, Michigan

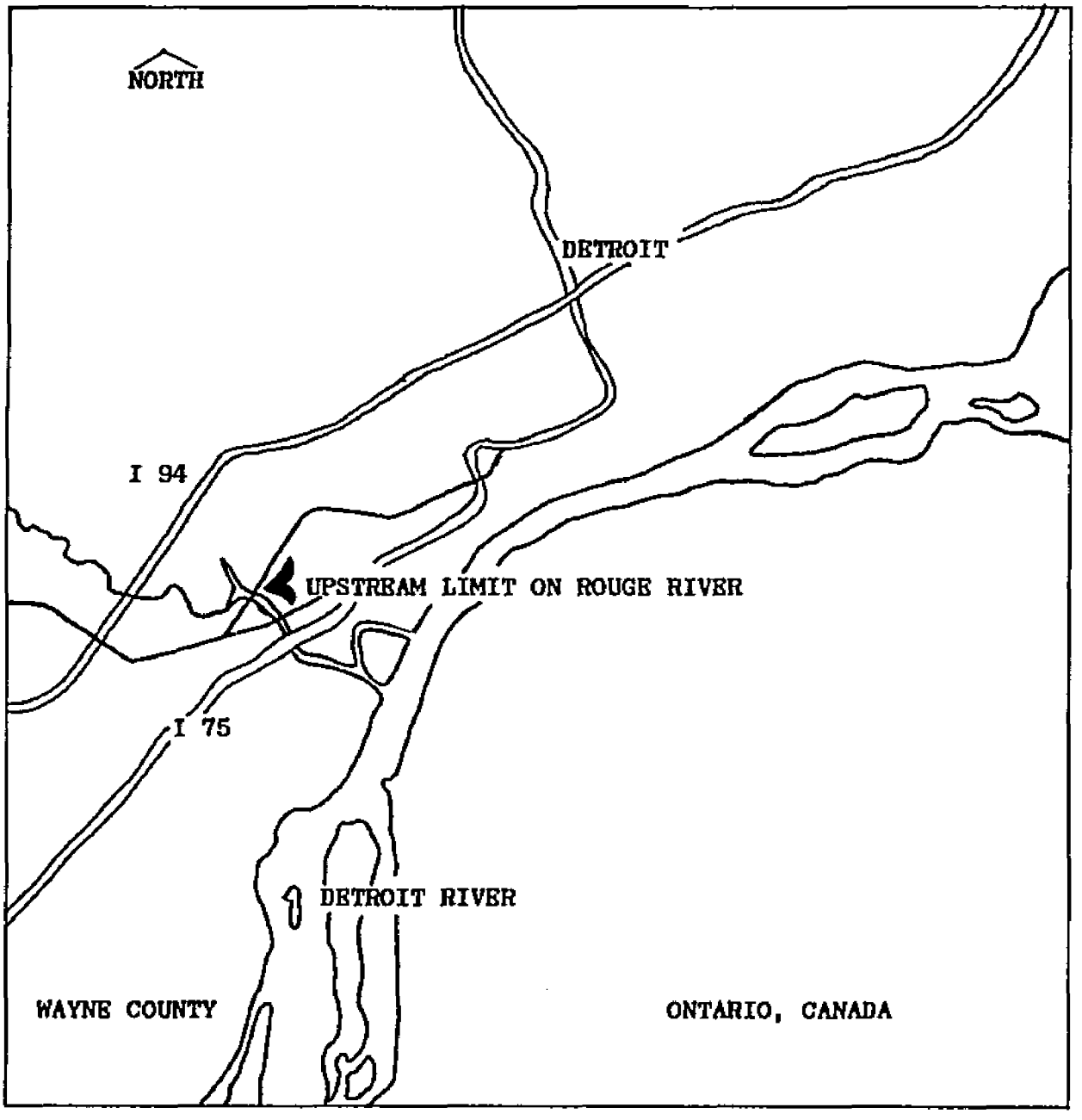

Figure 10. Upstream limit on Rouge River, Wayne County, Michigan

APPENDIX B

CODE BOOK FOR 1978 AND 1983 GREAT LAKES MARINA INVENTORIES

VARIABLE NAME	CODE FIELD	CODE
CASE	1 - 4	Sequential numbering of marinas
MONTH	5 - 6	Month photo was taken 01 - January 02 - February etc.
DAY	7 - 8	Day of the month photo was taken
YEAR	9 - 10	Year photo was taken
PHOTO	11 - 19	Photo identification number: roll, flight, frame
AGENCY	20	Agency have control of photos 1 - Land Resources Programs 2 - Mich. Department of Transportation 3 - Waterways Division 4 - Remote Sensing Program MSU
GLSERV	21	Great Lake Served by marina 1 - Michigan 2 - Superior 3 - Huron 4 - St. Clair 5 - Erie
COUNTY	22 - 23	County name 01 - Alcona 02 - Alger 03 - Allegan 04 - Alpena 05 - Antrim 06 - Arenac 07 - Baraga 09 - Bay 10 - Benzie 11 - Berrien 15 - Charlevoix 16 - Cheboygan 17 - Chippewa

VARIABLE NAME	CODE FIELD	CODE
COUNTY	22 - 23	County name 21 - Delta 24 - Emmet 27 - Gogebic 28 - Grand Traverse 31 - Houghton 32 - Huron 35 - Iosco 42 - Keweenaw 45 - Leelanau 48 - Luce 49 - Mackinac 50 - Macomb 51 - Manistee 52 - Marquette 53 - Mason 55 - Menominee 58 - Monroe 61 - Muskegon 64 - Oceana 66 - Ontonagon 70 - Ottawa 71 - Presque Isle 74 - St. Clair 76 - Sanilac 77 - Schoolcraft 79 - Tuscola 80 - Van Buren 82 - Wayne
SEC	24 - 25	Section of township
Tier	26 - 27	Tier of township
DIRECT1	28	North or South of baseline
RANGE	29 - 30	Range of township
DIRECT2	31	East or West of meridian
LRAMP	32	Launch ramp 1 - yes 0 - no
HOUT	33	Haul out facilities 1 - yes 0 - no
CDRY	34	Covered dry storage 1 - yes 0 - no

VARIABLE NAME	CODE FIELD	CODE
ODRY	35	Open dry storage 1 - yes 0 - no
REC	36	Land based recreation facilities 1 - yes 0 - no
LTTW	37 - 39	Slips less than twenty feet code number of slips
TWTOTH	40 - 42	Slips twenty to thirty feet code number of slips
THTOFO	43 - 45	Slips thirty to forty feet code number of slips
GTFO	46 - 48	Slips greater than forty feet code number of slips
BSIDE	49 - 51	Broadside mooring in feet code length
BUOY	52 - 54	Buoy mooring code number of buoys
MANAGE	55	Management type of marina 1 - commercial 2 - municipal 3 - state 4 - club 5 - other 6 - unknown
BREGION	56	Great Lakes Boating Region 1 - Southeast 2 - Southwest 3 - West Central 4 - Thumb 5 - Northeast 6 - Northwest 7 - Straits 8 - UP Lake Superior 9 - UP Lake Michigan

APPENDIX C

DIVISION BOUNDARIES OF GREAT LAKES FOR MARINA INVENTORIES

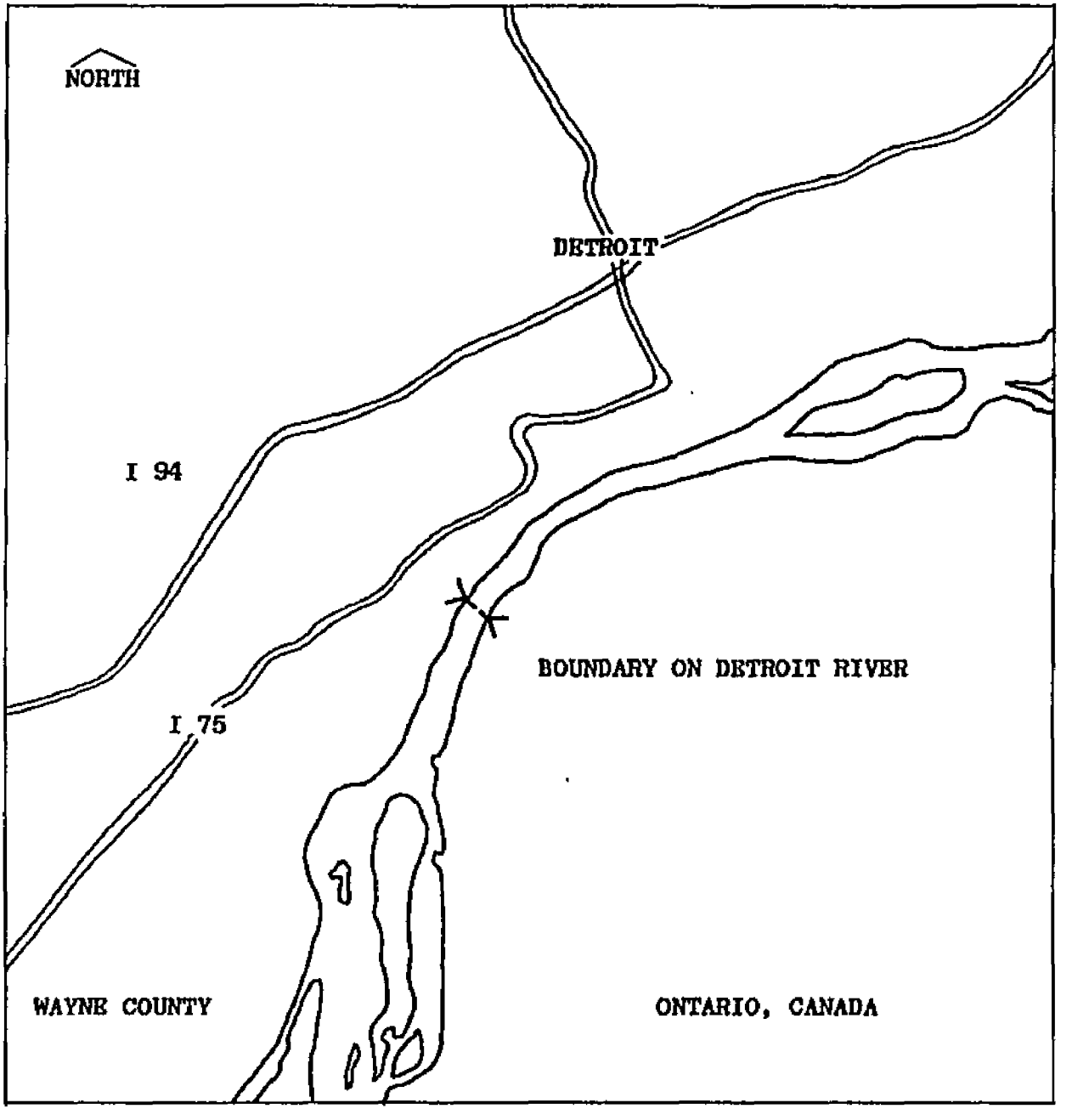

Figure 11. Boundary on Detroit River between Lake St. Clair and Lake Erie, Michigan

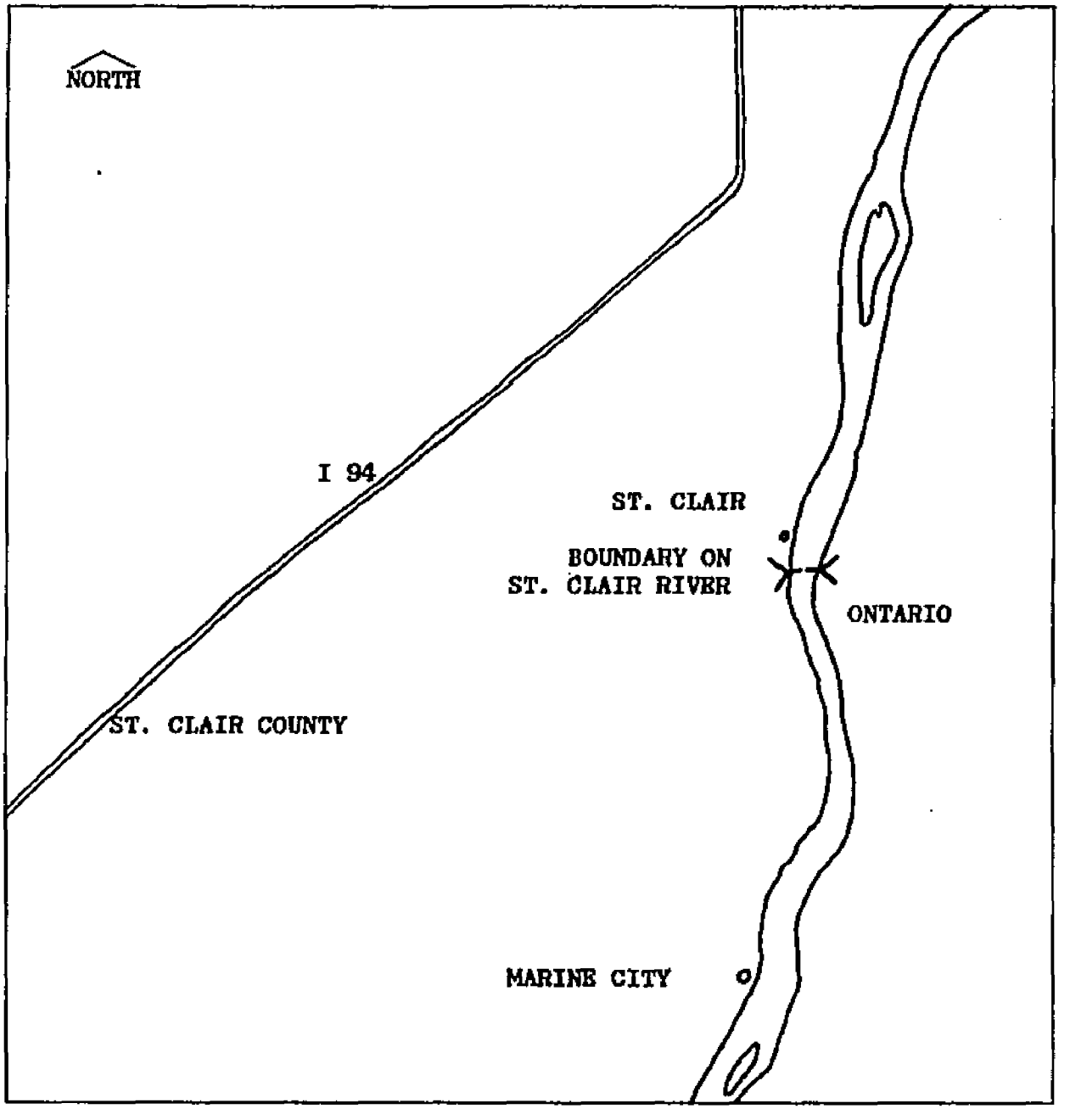

Figure 12. Boundary on St. Clair River between Lake St. Clair and Lake Huron, Michigan

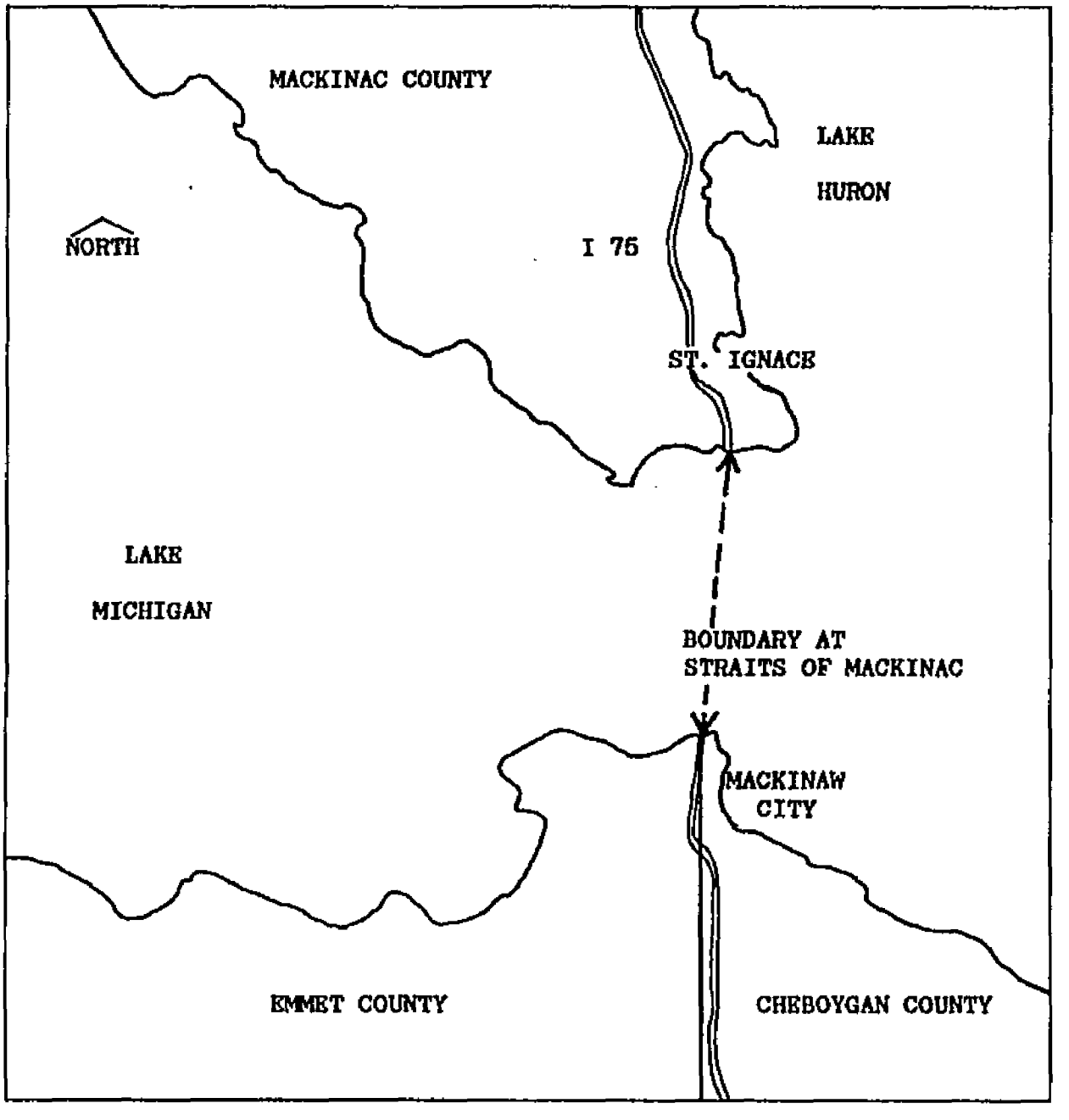

Figure 13. Boundary at Straits of Mackinac between Lake Huron and Lake Michigan, Michigan

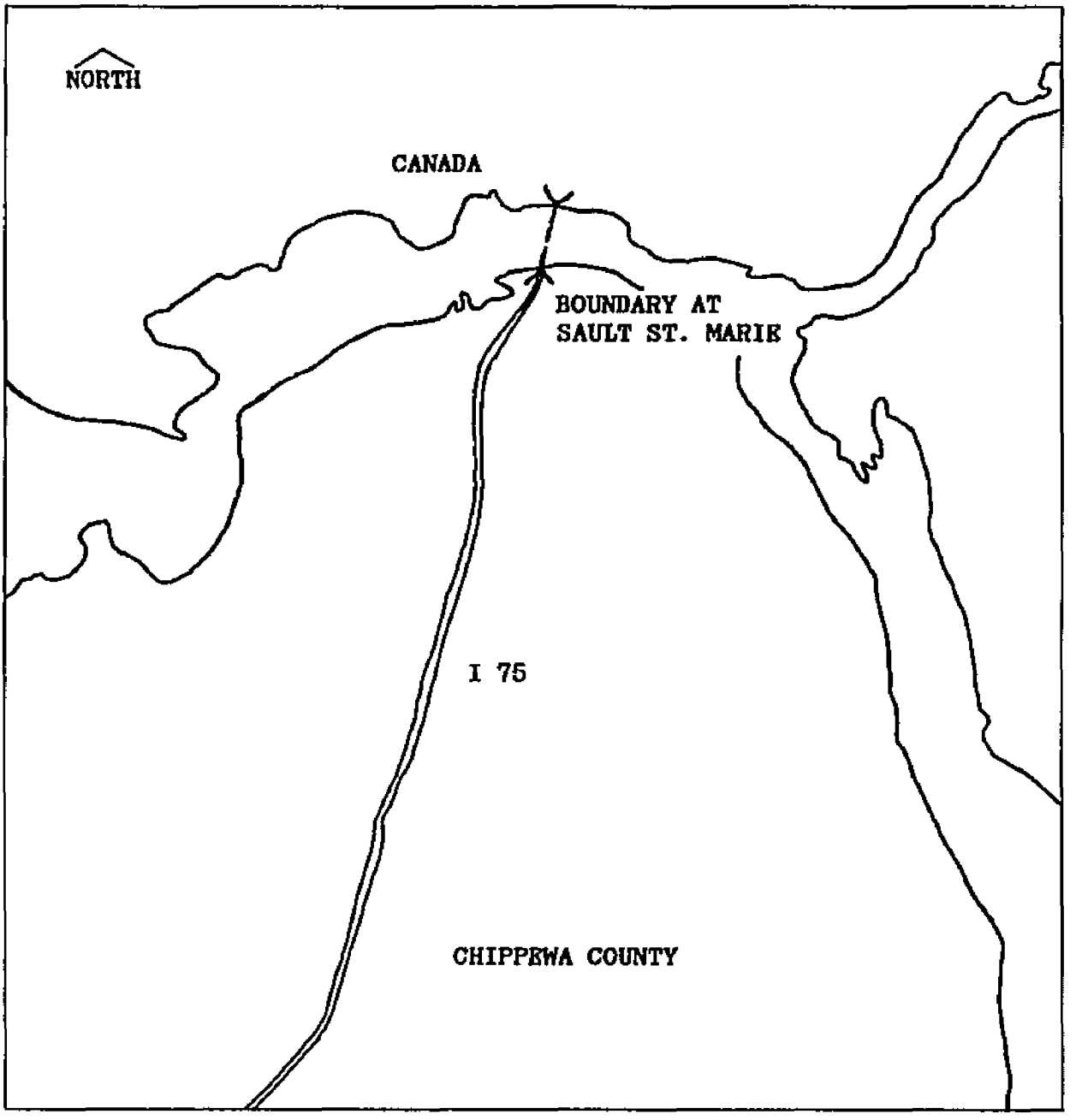

Figure 14. Boundary at Sault St. Marie between Lake Huron and Lake Superior, Michigan

APPENDIX D

1978 AND 1983 MICHIGAN REGIONAL MARINA MOORINGS

Table 26. 1978 and 1983 Regional Marina Moorings for Michigan Planning Regions

REGIONS	1978	1983
1. DETROIT	19020	21849
A. WAYNE CO.	5887	6405
B. OAKLAND/MACOMB	7405	8360
C. OUTER COUNTIES	5728	7084
2. JACKSON	0	0
3. KALAMAZOO/BATTLE CK	0	0
4. BENTON HARBOR/ST. JOSEPH	1879	2546
5. FLINT	0	0
6. LANSING	0	0
7. SAGINAW/BAY CITY	3664	4336
A. CENTRAL	1384	1634
B. THUMB	1235	1378
C. NORTH	1045	1324
8. GRAND RAPIDS	883	1146
A. SOUTH	682	731
B. NORTH	201	415
9. ALPENA	624	606
10. TRAVERSE BAY	2623	3226
11. SAULT ST. MARIE	1932	2071
12. ESCANABA/MARQUETTE/IRON MT.	866	846
13. HOUGHTON/IRONWOOD	518	564
14. MUSKEGON	3645	4306
TOTAL	35654	41496

APPENDIX E

MICHIGAN BOAT REGISTRATIONS BY REGION

Table 27. Michigan Boat Registrations By Great Lakes Boating Region

REGION	1977	1978	1980	1983
		GREATER THAN 20 FEET		
SOUTHEAST	28550	30515	32915	34229
SOUTHWEST	9206	9630	9697	9439
WEST CENTRAL	6565	6900	7428	7939
THUMB	6001	6484	7011	7705
NORTHEAST	1825	1974	2075	2216
NORTHWEST	3177	3348	3585	3832
STRAITS	1352	1450	1523	1583
UP LAKE SUPERIOR	977	1058	1017	1064
UP LAKE MICHIGAN	383	414	413	421
OUT-OF-STATE	2094	2148	2303	2963
TOTAL	60130	63921	67967	71391
		LESS THAN OR EQUAL TO 20 FEET		
SOUTHEAST	175109	182262	174276	168314
SOUTHWEST	101784	107612	101193	97930
WEST CENTRAL	64349	67417	65109	65223
THUMB	71029	74743	72056	70811
NORTHEAST	19210	20606	19629	20256
NORTHWEST	36065	37935	36935	37548
STRAITS	15664	16930	16240	16129
UP LAKE SUPERIOR	17794	19289	18282	17939
UP LAKE MICHIGAN	6477	6974	6752	6757
OUT-OF-STATE	17381	17542	16657	18593
TOTAL	524862	551310	527130	519500

APPENDIX F

MICHIGAN BOAT USE DISTRIBUTION BY SIZE CLASS AND WATER TYPE

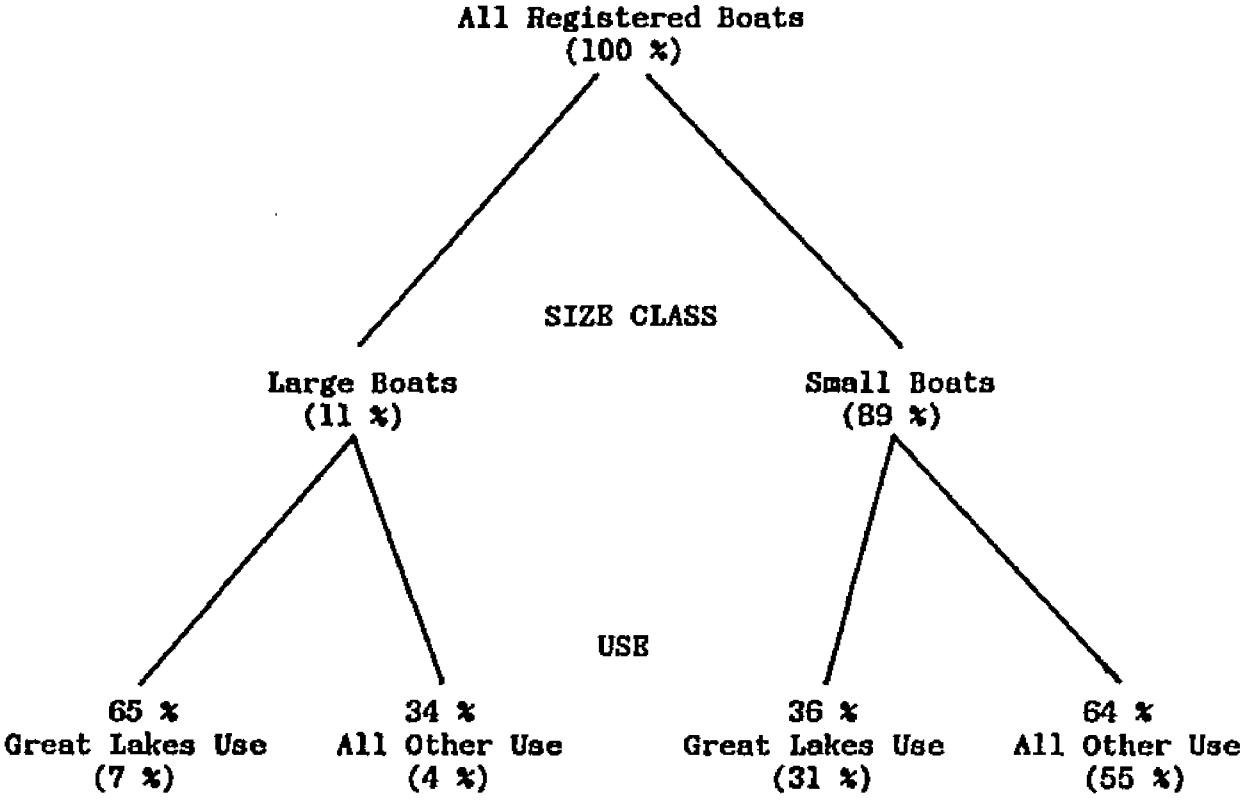

Figure 15. Michigan Boat Use Distribution by Size Class and Water Type

APPENDIX G

GREAT LAKES BOAT DAYS ORIGIN/DESTINATION TABLES 1977 AND 1980

Table 28. 1977 Michigan Origin/Destination Great Lakes Boat Days[a] by Great Lakes Boating Region

ORIGIN REGIONS	DESTINATION REGIONS 1	2	3	4	5	6	7	8	9
	1,000'S OF BOAT DAYS								
1 SOUTHEAST	1883	2	17	92	40	63	83	13	3
2 SOUTHWEST	10	211	40	3	4	44	26	4	2
3 WEST CENTRAL	13	17	326	5	2	29	17	2	1
4 THUMB	21	0	4	295	30	39	34	4	1
5 NORTHEAST	1	0	1	2	67	3	9	1	1
6 NORTHWEST	0	0	2	0	0	180	6	0	0
7 STRAITS	7	0	2	2	0	4	196	0	0
8 UP LAKE SUPERIOR	1	0	0	0	2	3	1	122	5
9 UP LAKE MICHIGAN	1	0	0	0	0	0	0	5	43
OUT OF STATE	21	30	6	1	0	20	60	7	1
TOTAL	1957	260	398	400	146	384	433	158	58

[a] A boat day is any part of a day spent on a boat actually in the water under power or sail (Stynes and Holecek, 1981).

Table 29. 1980 Michigan Origin/Destination Boat Days[a] by Great Lakes Boating Region

ORIGIN REGIONS	DESTINATION REGIONS 1	2	3	4	5	6	7	8	9
	1,000'S OF BOAT DAYS								
1 SOUTHEAST	2155	9	27	175	25	81	109	19	18
2 SOUTHWEST	11	160	60	8	8	26	20	2	1
3 WEST CENTRAL	3	17	330	19	1	56	20	2	6
4 THUMB	45	1	7	633	59	48	16	0	0
5 NORTHEAST	4	1	0	9	86	3	7	3	0
6 NORTHWEST	6	0	6	6	0	340	41	1	0
7 STRAITS	1	0	0	0	0	1	172	1	0
8 UP LAKE SUPERIOR	5	0	1	3	0	1	1	237	5
9 UP LAKE MICHIGAN	0	0	0	0	0	1	3	7	91
OUT OF STATE	4	18	36	1	4	25	21	7	0
TOTAL	2235	207	468	854	184	591	410	279	121

[a] A boat day is any part of a day spent on a boat actually in the water under power or sail (Stynes and Safronoff, 1982).

Table 30. Comparison of 1978 and 1983 Michigan Great Lakes Marina Slips Less Than 20 Feet by County and Great Lakes Boating Region

COUNTY	1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	3025	3279	254	8.4
MONROE	823	1229	406	49.3
ST. CLAIR	1081	1052	-29	-2.7
WAYNE	1727	1778	51	3.0
SUBTOTAL	6656	7338	682	10.2
		SOUTHWEST REGION		
ALLEGAN	178	200	22	12.4
BERRIEN	659	850	191	29.0
VAN BUREN	213	222	9	4.2
SUBTOTAL	1050	1272	222	21.1
		WEST CENTRAL REGION		
MUSKEGON	485	501	16	3.3
OCEANA	59	49	-10	-17.0
OTTAWA	460	327	-133	-28.9
SUBTOTAL	1004	877	-127	-12.6
		THUMB REGION		
ARENAC	222	271	49	22.1
BAY	182	188	6	3.3
HURON	539	492	-47	-8.7
SANILAC	10	13	3	30.0
TUSCOLA	44	44	0	0
SUBTOTAL	997	1008	11	1.1
		NORTHEAST REGION		
ALCONA	0	0	0	0
ALPENA	18	6	-12	-66.7
IOSCO	267	319	52	19.5
SUBTOTAL	285	325	40	14.0

Table 30 (cont'd.).

COUNTY	1978	1983	NET CHANGE	% CHANGE
		NORTHWEST REGION		
ANTRIM	44	44	0	0
BENZIE	2	9	7	350.0
CHARLEVOIX	168	159	-9	-5.4
GR. TRAVERSE	57	57	0	0
LEELANAU	36	26	-10	-27.8
MANISTEE	249	295	46	18.5
MASON	37	49	12	32.4
SUBTOTAL	593	639	46	7.0
		STRAITS REGION		
CHEBOYGAN	46	48	2	4.4
CHIPPEWA	518	515	-3	-0.6
EMMET	165	152	-13	-7.9
MACKINAC	301	321	20	6.6
PRESQUE ISLE	12	12	0	0
SUBTOTAL	1042	1048	6	0.6
		UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0
BARAGA	66	54	-12	-18.2
GOGEBIC	0	0	0	0
HOUGHTON	50	34	-16	-32.0
KEWEENAW	0	14	14	
LUCE	0	0	0	0
MARQUETTE	39	39	0	0
ONTONAGON	13	13	0	0
SUBTOTAL	168	154	-14	-8.0
		UP LAKE MICHIGAN REGION		
DELTA	81	84	3	3.7
MENOMINEE	6	0	-6	-100.0
SCHOOLCRAFT	0	0	0	0
SUBTOTAL	87	84	-3	-3.4
TOTAL	11882	12745	863	7.3

Table 31. Comparison of 1978 and 1983 Michigan Great Lakes Marina Slips 20 Feet to 30 Feet by County and Great Lakes Boating Region

COUNTY	1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	2524	3046	522	20.7
MONROE	739	1172	433	58.6
ST. CLAIR	1288	1567	279	21.7
WAYNE	2207	2541	334	15.1
SUBTOTAL	6758	8326	1568	23.2
		SOUTHWEST REGION		
ALLEGAN	54	54	0	0
BERRIEN	329	492	163	49.5
VAN BUREN	140	322	182	130.0
SUBTOTAL	523	868	345	66.0
		WEST CENTRAL REGION		
MUSKEGON	305	388	83	27.2
OCEANA	45	48	3	6.7
OTTAWA	866	1121	255	29.4
SUBTOTAL	1216	1557	341	28.0
		THUMB REGION		
ARENAC	30	120	90	300.0
BAY	608	781	173	28.5
HURON	238	243	5	2.1
SANILAC	4	98	94	2350.0
TUSCOLA	96	96	0	0
SUBTOTAL	976	1338	362	37.1
		NORTHEAST REGION		
ALCONA	0	0	0	0
ALPENA	54	54	0	0
IOSCO	116	228	112	96.6
SUBTOTAL	170	282	112	65.9

Table 31 (cont'd.).

COUNTY	1978	1983	NET CHANGE	% CHANGE
		NORTHWEST REGION		
ANTRIM	12	12	0	0
BENZIE	87	121	34	39.1
CHARLEVOIX	118	217	99	89.9
GR. TRAVERSE	107	107	0	0
LEELANAU	117	271	154	131.6
MANISTEE	168	254	86	51.2
MASON	94	182	88	93.6
SUBTOTAL	703	1164	461	65.6
		STRAITS REGION		
CHEBOYGAN	95	95	0	0
CHIPPEWA	149	212	63	42.3
EMMET	62	62	0	0
MACKINAC	109	120	11	10.1
PRESQUE ISLE	22	22	0	0
SUBTOTAL	437	511	74	16.9
		UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0
BARAGA	49	73	24	49.0
GOGEBIC	0	0	0	0
HOUGHTON	44	44	0	0
KEWEENAW	116	228	112	96.6
LUCE	0	0	0	0
MARQUETTE	50	50	0	0
ONTONAGON	3	15	12	400.0
SUBTOTAL	262	410	148	56.5
		UP LAKE MICHIGAN REGION		
DELTA	24	43	19	79.2
MENOMINEE	8	8	0	0
SCHOOLCRAFT	11	11	0	0
SUBTOTAL	43	62	19	44.2
TOTAL	10926	14244	3318	30.4

Table 32. Comparison of 1978 and 1983 Michigan Great Lakes Marina Slips 30 Feet to 40 Feet by County and Great Lakes Boating Region

COUNTY	1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	1042	1174	132	12.7
MONROE	211	298	87	41.2
ST. CLAIR	628	787	159	25.3
WAYNE	947	1066	119	12.6
SUBTOTAL	2828	3325	497	17.6
		SOUTHWEST REGION		
ALLEGAN	102	127	25	24.5
BERRIEN	231	304	73	31.6
VAN BUREN	4	11	7	175.0
SUBTOTAL	337	442	105	31.2
		WEST CENTRAL REGION		
MUSKEGON	59	130	71	120.3
OCEANA	34	38	4	11.8
OTTAWA	409	700	291	71.1
SUBTOTAL	502	868	336	66.9
		THUMB REGION		
ARENAC	7	16	9	128.6
BAY	225	347	122	54.2
HURON	53	83	30	56.6
SANILAC	26	48	22	84.6
TUSCOLA	6	6	0	0
SUBTOTAL	317	500	183	57.7
		NORTHEAST REGION		
ALCONA	0	0	0	0
ALPENA	63	63	0	0
IOSCO	9	84	75	833.3
SUBTOTAL	72	147	75	104.2

Table 32 (cont'd.).

COUNTY	1978	1983	NET CHANGE	% CHANGE
		NORTHWEST REGION		
ANTRIM	0	0	0	0
BENZIE	8	48	40	500.0
CHARLEVOIX	114	228	114	100.0
GR. TRAVERSE	11	11	0	0
LEELANAU	94	87	-7	-7.4
MANISTEE	27	39	12	44.4
MASON	0	102	102	
SUBTOTAL	254	515	261	102.8
		STRAITS REGION		
CHEBOYGAN	55	55	0	0
CHIPPEWA	69	68	-1	-1.4
EMMET	87	96	9	10.3
MACKINAC	32	30	-2	-6.3
PRESQUE ISLE	40	40	0	0
SUBTOTAL	283	289	6	2.1
		UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0
BARAGA	0	6	6	
GOGEBIC	0	0	0	0
HOUGHTON	31	31	0	0
KEWEENAW	0	0	0	0
LUCE	0	0	0	0
MARQUETTE	16	16	0	0
ONTONAGON	16	4	-12	-75.0
SUBTOTAL	63	57	-6	-9.5
		UP LAKE MICHIGAN REGION		
DELTA	14	20	6	42.9
MENOMINEE	25	25	0	0
SCHOOLCRAFT	0	0	0	0
SUBTOTAL	39	45	6	15.4
TOTAL	4695	6188	1493	31.8

Table 33. Comparison of 1978 and 1983 Michigan Great Lakes Marina Slips Greater Than 40 Feet by County and Great Lakes Boating Region

COUNTY	1978	1983	NET CHANGE	% CHANGE
		SOUTHEAST REGION		
MACOMB	418	452	34	8.1
MONROE	61	111	50	82.0
ST. CLAIR	249	251	2	0.8
WAYNE	614	731	117	19.1
SUBTOTAL	1342	1545	203	15.1
		SOUTHWEST REGION		
ALLEGAN	327	329	2	0.6
BERRIEN	75	118	43	57.3
VAN BUREN	64	66	2	3.0
SUBTOTAL	466	513	47	10.1
		WEST CENTRAL REGION		
MUSKEGON	89	103	14	15.7
OCEANA	20	36	16	80.0
OTTAWA	202	269	67	33.2
SUBTOTAL	311	408	97	31.2
		THUMB REGION		
ARENAC	26	18	-8	-30.8
BAY	248	255	7	2.8
HURON	52	65	13	25.0
SANILAC	17	28	11	64.7
TUSCOLA	0	0	0	0
SUBTOTAL	343	366	23	6.7
		NORTHEAST REGION		
ALCONA	14	14	0	0
ALPENA	85	85	0	0
IOSCO	2	0	-2	-100
SUBTOTAL	101	99	-2	-2.0

Table 33 (cont'd.).

COUNTY	1978	1983	NET CHANGE	% CHANGE
		NORTHWEST REGION		
ANTRIM	12	12	0	0
BENZIE	0	26	26	
CHARLEVOIX	80	115	35	43.8
GR. TRAVERSE	0	0	0	0
LEELANAU	40	33	-7	-17.5
MANISTEE	36	41	5	13.9
MASON	2	9	7	350.0
SUBTOTAL	170	236	66	38.8
		STRAITS REGION		
CHEBOYGAN	17	17	0	0
CHIPPEWA	12	13	1	8.3
EMMET	63	71	8	12.7
MACKINAC	78	86	8	10.3
PRESQUE ISLE	18	18	0	0
SUBTOTAL	188	205	17	9.0
		UP LAKE SUPERIOR REGION		
ALGER	0	0	0	0
BARAGA	0	0	0	0
GOGEBIC	0	0	0	0
HOUGHTON	52	52	0	0
KEWEENAW	0	0	0	0
LUCE	0	0	0	0
MARQUETTE	9	9	0	0
ONTONAGON	6	21	15	250.0
SUBTOTAL	67	82	15	22.4
		UP LAKE MICHIGAN REGION		
DELTA	0	0	0	0
MENOMINEE	8	8	0	0
SCHOOLCRAFT	12	12	0	0
SUBTOTAL	20	20	0	0
TOTAL	3008	3474	466	15.5

APPENDIX I

COMPARISON OF LAUNCH RAMP FACILITIES INVENTORIED 1978 AND 1983 BY COUNTY AND GREAT LAKES BOATING REGION

Table 34. Comparison of 1978 and 1983 Michigan Great Lakes Marina Launch Ramp Facilities by County and Great Lakes Boating Region

COUNTY	1978	1983
SOUTHEAST REGION		
MACOMB	35	36
MONROE	19	22
ST. CLAIR	31	29
WAYNE	31	29
SUBTOTAL	116	116
SOUTHWEST REGION		
ALLEGAN	0	0
BERRIEN	3	6
VAN BUREN	6	6
SUBTOTAL	9	12
WEST CENTRAL REGION		
MUSKEGON	9	10
OCEANA	5	5
OTTAWA	17	18
SUBTOTAL	31	33
THUMB REGION		
ARENAC	8	8
BAY	9	11
HURON	18	18
SANILAC	1	1
TUSCOLA	2	2
SUBTOTAL	38	40
NORTHEAST REGION		
ALCONA	1	1
ALPENA	3	3
IOSCO	6	8
SUBTOTAL	10	12

Table 34 (cont'd.).

COUNTY	1978	1983
	NORTHWEST REGION	
ANTRIM	1	1
BENZIE	2	2
CHARLEVOIX	10	12
GR. TRAVERSE	1	1
LEELANAU	7	7
MANISTEE	10	10
MASON	2	3
SUBTOTAL	33	36
	STRAITS REGION	
CHEBOYGAN	5	5
CHIPPEWA	44	44
EMMET	2	2
MACKINAC	21	22
PRESQUE ISLE	3	3
SUBTOTAL	75	76
	UP LAKE SUPERIOR REGION	
ALGER	2	2
BARAGA	3	4
GOGEBIC	1	1
HOUGHTON	6	6
KEWEENAW	3	4
LUCE	0	0
MARQUETTE	3	3
ONTONAGON	1	1
SUBTOTAL	19	21
	UP LAKE MICHIGAN REGION	
DELTA	10	10
MENOMINEE	1	1
SCHOOLCRAFT	0	0
SUBTOTAL	11	11
TOTAL	342	357

APPENDIX J

COMPARISON OF HAUL OUT FACILITIES INVENTORIED 1978 AND 1983 BY COUNTY AND GREAT LAKES BOATING REGION

Table 35. Comparison of 1978 and 1983 Michigan Great Lakes Marina Haul Out Facilities by County and Great Lakes Boating Region

COUNTY	1978	1983
	SOUTHEAST REGION	
MACOMB	36	37
MONROE	9	10
ST. CLAIR	23	22
WAYNE	25	26
SUBTOTAL	93	95
	SOUTHWEST REGION	
ALLEGAN	3	3
BERRIEN	3	6
VAN BUREN	3	3
SUBTOTAL	9	12
	WEST CENTRAL REGION	
MUSKEGON	6	6
OCEANA	1	1
OTTAWA	15	17
SUBTOTAL	22	24
	THUMB REGION	
ARENAC	0	0
BAY	4	6
HURON	5	5
SANILAC	1	1
TUSCOLA	1	1
SUBTOTAL	11	13
	NORTHEAST REGION	
ALCONA	0	0
ALPENA	2	2
IOSCO	2	2
SUBTOTAL	4	4

Table 35 (cont'd.).

COUNTY	1978	1983
	NORTHWEST REGION	
ANTRIM	0	0
BENZIE	0	1
CHARLEVOIX	5	5
GR. TRAVERSE	0	0
LEELANAU	3	4
MANISTEE	4	4
MASON	1	1
SUBTOTAL	13	15
	STRAITS REGION	
CHEBOYGAN	4	4
CHIPPEWA	2	2
EMMET	3	3
MACKINAC	2	2
PRESQUE ISLE	0	0
SUBTOTAL	11	11
	UP LAKE SUPERIOR REGION	
ALGER	1	1
BARAGA	0	0
GOGEBIC	0	0
HOUGHTON	2	2
KEWEENAW	0	0
LUCE	0	0
MARQUETTE	2	2
ONTONAGON	1	1
SUBTOTAL	6	6
	UP LAKE MICHIGAN REGION	
DELTA	1	1
MENOMINEE	0	0
SCHOOLCRAFT	0	0
SUBTOTAL	1	1
TOTAL	170	181

APPENDIX K

COMPARISON OF COVERED DRY STORAGE FACILITIES INVENTORIED 1978 AND 1983 BY COUNTY AND GREAT LAKES BOATING REGION

Table 36. Comparison of 1978 and 1983 Michigan Great Lakes Marina Covered Dry Storage Facilities by County and Great Lakes Boating Region

COUNTY	1978	1983
SOUTHEAST REGION		
MACOMB	34	33
MONROE	11	13
ST. CLAIR	34	33
WAYNE	18	18
SUBTOTAL	97	97
SOUTHWEST REGION		
ALLEGAN	6	6
BERRIEN	5	7
VAN BUREN	5	4
SUBTOTAL	16	17
WEST CENTRAL REGION		
MUSKEGON	9	9
OCEANA	4	4
OTTAWA	15	15
SUBTOTAL	28	28
THUMB REGION		
ARENAC	3	3
BAY	7	9
HURON	10	10
SANILAC	2	2
TUSCOLA	1	1
SUBTOTAL	23	25
NORTHEAST REGION		
ALCONA	0	0
ALPENA	3	3
IOSCO	6	7
SUBTOTAL	9	10

Table 36 (cont'd.).

COUNTY	1978	1983
	NORTHWEST REGION	
ANTRIM	0	0
BENZIE	2	2
CHARLEVOIX	7	7
GR. TRAVERSE	1	1
LEELANAU	3	3
MANISTEE	6	6
MASON	4	4
SUBTOTAL	23	23
	STRAITS REGION	
CHEBOYGAN	6	6
CHIPPEWA	15	15
EMMET	4	4
MACKINAC	6	5
PRESQUE ISLE	2	2
SUBTOTAL	33	32
	UP LAKE SUPERIOR REGION	
ALGER	2	2
BARAGA	0	0
GOGEBIC	0	0
HOUGHTON	4	4
KEWEENAW	0	0
LUCE	0	0
MARQUETTE	2	2
ONTONAGON	0	0
SUBTOTAL	8	8
	UP LAKE MICHIGAN REGION	
DELTA	4	3
MENOMINEE	1	1
SCHOOLCRAFT	0	0
SUBTOTAL	5	4
TOTAL	242	244

APPENDIX L

COMPARISON OF OPEN DRY STORAGE FACILITIES INVENTORIED 1978 AND 1983 BY COUNTY AND GREAT LAKES BOATING REGION

Table 37. Comparison of 1978 and 1983 Michigan Great Lakes Marina Open Dry Storage Facilities by County and Great Lakes Boating Region

COUNTY	1978	1983
	SOUTHEAST REGION	
MACOMB	44	44
MONROE	18	21
ST. CLAIR	43	39
WAYNE	37	38
SUBTOTAL	142	142
	SOUTHWEST REGION	
ALLEGAN	9	9
BERRIEN	6	8
VAN BUREN	11	11
SUBTOTAL	26	28
	WEST CENTRAL REGION	
MUSKEGON	12	12
OCEANA	4	4
OTTAWA	23	23
SUBTOTAL	39	39
	THUMB REGION	
ARENAC	6	6
BAY	10	13
HURON	18	19
SANILAC	2	2
TUSCOLA	2	2
SUBTOTAL	38	42
	NORTHEAST REGION	
ALCONA	1	1
ALPENA	3	3
IOSCO	8	10
SUBTOTAL	12	14

Table 37 (cont'd.).

COUNTY	1978	1983
	NORTHWEST REGION	
ANTRIM	1	1
BENZIE	4	4
CHARLEVOIX	8	10
GR. TRAVERSE	0	0
LEELANAU	5	5
MANISTEE	12	13
MASON	5	6
SUBTOTAL	35	39
	STRAITS REGION	
CHEBOYGAN	6	6
CHIPPEWA	42	42
EMMET	4	4
MACKINAC	12	11
PRESQUE ISLE	2	2
SUBTOTAL	66	65
	UP LAKE SUPERIOR REGION	
ALGER	2	2
BARAGA	3	4
GOGEBIC	0	0
HOUGHTON	7	7
KEWEENAW	0	0
LUCE	0	0
MARQUETTE	2	2
ONTONAGON	2	2
SUBTOTAL	16	17
	UP LAKE MICHIGAN REGION	
DELTA	9	9
MENOMINEE	1	1
SCHOOLCRAFT	0	0
SUBTOTAL	10	10
TOTAL	348	396

APPENDIX M

COMPARISON OF LAND BASED RECREATIONAL FACILITIES INVENTORIED 1978 AND 1983 BY COUNTY AND GREAT LAKES BOATING REGION

Table 38. Comparison of 1978 and 1983 Michigan Great Lakes Marina Land Based Recreational Facilities by County and Great Lakes Boating Region

COUNTY	1978	1983
	SOUTHEAST REGION	
MACOMB	5	6
MONROE	0	0
ST. CLAIR	6	7
WAYNE	17	18
SUBTOTAL	28	31
	SOUTHWEST REGION	
ALLEGAN	4	6
BERRIEN	0	1
VAN BUREN	1	1
SUBTOTAL	5	8
	WEST CENTRAL REGION	
MUSKEGON	2	2
OCEANA	0	0
OTTAWA	5	6
SUBTOTAL	7	8
	THUMB REGION	
ARENAC	0	0
BAY	0	0
HURON	1	1
SANILAC	0	1
TUSCOLA	0	0
SUBTOTAL	1	2
	NORTHEAST REGION	
ALCONA	0	0
ALPENA	0	0
IOSCO	1	1
SUBTOTAL	1	1

Table 38 (cont'd.).

COUNTY	1978	1983
	NORTHWEST REGION	
ANTRIM	0	0
BENZIE	0	1
CHARLEVOIX	4	4
GR. TRAVERSE	0	0
LEELANAU	1	1
MANISTEE	2	2
MASON	0	1
SUBTOTAL	7	9
	STRAITS REGION	
CHEBOYGAN	0	0
CHIPPEWA	3	3
EMMET	4	4
MACKINAC	2	3
PRESQUE ISLE	0	0
SUBTOTAL	9	10
	UP LAKE SUPERIOR REGION	
ALGER	0	0
BARAGA	0	0
GOGEBIC	0	0
HOUGHTON	0	0
KEWEENAW	0	0
LUCE	0	0
MARQUETTE	0	0
ONTONAGON	0	0
SUBTOTAL	0	0
	UP LAKE MICHIGAN REGION	
DELTA	2	2
MENOMINEE	0	0
SCHOOLCRAFT	1	1
SUBTOTAL	3	3
TOTAL	61	73

APPENDIX N

1978 AND 1983 REGIONAL SUPPLY/DEMAND RATIO QUOTIENTS

Table 39. 1978 and 1983 Regional Supply/Demand Ratios for Michigan Great Lakes Boating Regions

REGION	1978 SUPPLY / DEMAND RATIOS[a]				
	A	B	C	D	E
SOUTHEAST	3.97	0.09	0.23	0.97	0.21
SOUTHWEST	1.86	0.02	0.06	0.42	0.21
WEST CENTRAL	3.84	0.05	0.13	0.82	0.20
THUMB	2.51	0.04	0.10	0.72	0.16
NORTHEAST	5.95	0.04	0.10	0.69	0.13
NORTHWEST	6.86	0.06	0.15	1.06	0.13
STRAITS	25.79	0.16	0.42	3.08	0.14
UP LAKE SUPERIOR	4.08	0.04	0.11	1.25	0.12
UP LAKE MICHIGAN	6.91	0.07	0.19	1.97	0.20
TOTAL	3.88	0.06	0.16	0.90	0.18

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes
E. Moorings per registered boat used on the Great Lakes by destination

Table 39 (cont'd.).

REGION	1983 SUPPLY / DEMAND RATIOS[a]				
	A	B	C	D	E
SOUTHEAST	4.74	0.11	0.27	0.99	0.28
SOUTHWEST	2.34	0.03	0.08	0.54	0.45
WEST CENTRAL	4.36	0.06	0.15	0.84	0.26
THUMB	2.99	0.04	0.12	0.71	0.12
NORTHEAST	6.77	0.05	0.12	0.72	0.16
NORTHWEST	8.72	0.08	0.20	1.27	0.15
STRAITS	26.69	0.17	0.45	2.94	0.21
UP LAKE SUPERIOR	4.33	0.05	0.13	1.29	0.09
UP LAKE MICHIGAN	7.15	0.07	0.20	1.95	0.12
TOTAL	4.58	0.07	0.19	0.94	0.22

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes
E. Moorings per registered boat used on the Great Lakes by destination

Table 40. 1978 and 1983 Regional Supply/Demand Ratios for Michigan Planning Regions

REGION	1978 SUPPLY / DEMAND RATIOS[a]			
	A	B	C	D
1. DETROIT	4.04	0.09	0.23	0.98
A. WAYNE CO.	2.46	0.07	0.19	0.86
B. OAKLAND/MACOMB	4.35	0.08	0.21	0.78
C. OUTER COUNTIES	9.36	0.15	0.39	1.95
2. JACKSON	0.00	0.00	0.00	0.00
3. KALAMAZOO/BATTLE CK	0.00	0.00	0.00	0.00
4. BENTON HARBOR/ST. JOSEPH	6.83	0.07	0.18	1.20
5. FLINT	0.00	0.00	0.00	0.00
6. LANSING	0.00	0.00	0.00	0.00
7. SAGINAW/BAY CITY	4.82	0.06	0.16	1.10
A. CENTRAL	2.71	0.04	0.10	0.73
B. THUMB	9.42	0.16	0.43	3.16
C. NORTH	8.77	0.06	0.16	1.02
8. GRAND RAPIDS	1.22	0.01	0.04	0.28
A. SOUTH	1.13	0.01	0.04	0.26
B. NORTH	1.70	0.02	0.04	0.35
9. ALPENA	5.45	0.04	0.10	0.76
10. TRAVERSE BAY	13.38	0.09	0.23	1.48
11. SAULT ST. MARIE	39.43	0.22	0.59	5.02
12. ESCANABA/MARQUETTE/IRON MT.	4.66	0.05	0.14	1.49
13. HOUGHTON/IRONWOOD	5.56	0.05	0.14	1.49
14. MUSKEGON	11.07	0.14	0.36	2.04
TOTAL	3.88	0.06	0.16	0.90

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes

Table 40 (cont'd.).

REGION	1983 SUPPLY / DEMAND RATIOS[a]			
	A	B	C	D
1. DETROIT	4.83	0.11	0.28	1.01
A. WAYNE CO.	2.90	0.08	0.23	0.91
B. OAKLAND/MACOMB	4.96	0.09	0.23	0.76
C. OUTER COUNTIES	11.27	0.19	0.46	1.91
2. JACKSON	0.00	0.00	0.00	0.00
3. KALAMAZOO/BATTLE CK	0.00	0.00	0.00	0.00
4. BENTON HARBOR/ST. JOSEPH	9.26	0.09	0.28	1.62
5. FLINT	0.00	0.00	0.00	0.00
6. LANSING	0.00	0.00	0.00	0.00
7. SAGINAW/BAY CITY	5.69	0.07	0.18	1.09
A. CENTRAL	3.23	0.04	0.12	0.73
B. THUMB	10.50	0.18	0.46	2.59
C. NORTH	10.58	0.08	0.19	1.08
8. GRAND RAPIDS	1.49	0.02	0.05	0.32
A. SOUTH	1.14	0.02	0.04	0.25
B. NORTH	3.26	0.03	0.09	0.63
9. ALPENA	5.22	0.03	0.10	0.69
10. TRAVERSE BAY	15.24	0.11	0.28	1.56
11. SAULT ST. MARIE	46.23	0.23	0.70	5.87
12. ESCANABA/MARQUETTE/IRON MT.	4.69	0.05	0.14	1.45
13. HOUGHTON/IRONWOOD	6.18	0.06	0.17	1.66
14. MUSKEGON	12.72	0.16	0.42	1.94
TOTAL	4.58	0.07	0.19	0.94

[a]
A. Moorings per thousand population
B. Moorings per registered boat
C. Moorings per registered boat used on Great Lakes
D. Moorings per registered boat greater than 20 ft used on Great Lakes