Michigan. Coastal Zone Management Program

DOCUMENTATION AND ANALYSIS OF TEMPORAL AND SPATIAL CHANGES IN MARINAS SERVING MICHIGAN'S GREAT LAKES

DOCUMENTATION AND ANALYSIS

OF

TEMPORAL AND SPATIAL CHANGES

IN

MARINAS SERVING MICHIGAN'S GREAT LAKES

prepared by

Department of Park and Recreation Resources
Michigan State University

for

Waterways Division
and
Land Resource Programs Division

Michigan Department of Natural Resources

December 1983

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ACKNOWLEDGEMENTS

As we near the end of this research effort a few moments of reflection seem appropriate. We clearly recognize that many individuals contributed enormously to the progress of this research effort, and we would like to recognize and thank them here for their service to this project.

We express our appreciation to those who lent their expertise and time to facilitate the photography portion of this project. Charles Stanley deserves special recognition for making his plane available for this project and donating countless hours flying around the state. We also owe a special debt of gratitude to David and Roger Courey for the time and talent they donated as pilots. David Feltus, Yvonne Trombka, Robin Paterson, and Chuck Stanley were photographers for the project for which we are grateful.

Bettye Warren and Denise Morrison have done yeoman service in providing secretarial, bookkeeping and typing support for the project. Our thanks is owed for their effort.

Numerous students have worked on various aspects of the project and we are grateful for and impressed by their diligence and perseverence throughout their involvement. Specifically we thank Jeff Marsh, Tim Lambert and Laurel Klepinger. Interpretation of the state's historic aerial photographs was made much easier and enjoyable by the support and cooperation extended by Sherman Hollander and Michael Scieszka. We are deeply indebted to them both.

Financial support for the project was provided by a contract from Waterways Division and Land Resource Programs Division, Michigan Department of Natural Resources, with some additional commitments from the Michigan Agricultural Experiment Station, Michigan State University. Obviously without this support there would not have been a project. Special appreciation is

extended to Lester Nichols and Chris Shafer for having confidence in what we were trying to accomplish. Finally, we are indebted to Keith Wilson for his long term support for our recreation boating research program. His persistent requests for better information about Michigan's marinas are responsible for stimulating us to initiate this study.

With memory being the fallible mechanism that it is, we have undoubtably erred in failing to recall several who have contributed and for that we apologize. In the final analysis, any measure of success has been the result of many individuals to whom we are especially appreciative and indebted. Thank you all.

Gene Brothers
December 1983

Donald F. Holecek
East Lansing, Michigan

PREFACE

The following report is presented as the final portion of the contract between the Department of Park and Recreation Resources, Michigan State University and the Divisions of Waterways and Land Resource Programs, Michigan Department of Natural Resources. Other elements of the contract will be discussed here, but are presented as separate products. Products provided to the MDNR which fulfill our contract obligations are: this final report as well as several progress reports and an interim report; the original set of 1983 aerial photographs and index maps; acetate overlays delineating adjacent land uses; and finally a set of punch cards of the marina data inventoried from 1978 and 1983 aerial photographs. Due to the diversity and dynamic nature of marinas serving the Great Lakes, the figures presented here represent the findings of the authors as of the time aerial photographs were taken (June - September, 1983). The findings are also by necessity subject to limitations of photographic interpretation. For any errors of omission or commission we accept all responsibility, and we encourage comments and corrections.

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INTRODUCTION

As part of a continuing effort to identify, monitor, and interpret recreational opportunities and problems occurring along Michigan's Great Lakes coastline, this report is a discussion concerning marinas serving Michigan's Great Lakes. In previous boating related studies, it has been suggested or implied that an up-to-date inventory of marinas serving Michigan's Great Lakes was needed (Stynes and Holecek, 1980; Fridgen, Taber and Gillings, 1981; Stynes and Safronoff, 1981; Stynes, et al 1983). Waterways Division, Michigan Department of Natural Resources (MDNR) periodically has inventoried marinas and facilities serving the Great Lakes in Michigan. MDNR completed its last inventory of marinas serving the Great Lakes in 1977. The usefulness of this inventory, when applying it to current planning and policy decisions, is limited because of extensive development over the past seven years. This is also an attempt to establish a monitoring and information system which will better keep pace with marina development thereby extending its usefulness to a variety of applications. A different methodology, remote sensing, was employed in this study which, as will be noted subsequently, offers many advantages over previously employed methodologies.

Crompton, Beardsley, and Ditton (1976) suggest several applications of such an inventory when it is made available to a variety of users:

1) as supporting data to advocate the position of the boating and marina industry,
2) as an empirical base against which trends can be monitored through time,
3) as an information source for planning for future public needs, and

4) as a reference for individuals to locate and inquire as to the availability of storage in desired locations.

Policies and decisions are only as good as the information upon which they are based. It is essential that meaningful plans and decisions be supported by an accurate resource inventory, an ongoing data collection system and an analysis and access framework to handle these data. With these elements in mind, we formulated the following objectives for this study.

Objectives

1) To conduct a current inventory of public and private marinas serving Michigan's Great Lakes to include: berthing and mooring areas, haul-out service, dry storage facilities, and related services.

2) To compare levels of marina development inventoried from aerial photographs taken of the coastal region between 1977 & 1980 (most of these historic photographs were taken during 1978 and will therefore be referred to as 1978 photographs throughout the report) and aerial photographs taken in 1983.

3) To establish an information collection and storage system to facilitate analysis of future marina development.

These objectives provide a framework for the organization of this report. We will first discuss methods used in reaching each objective. This discussion will include rationale for selection of the methods. Results will then be discussed. In this section of the report, it is not our intention to present all possible combinations and permutations of these data but rather to give the reader a few examples of the ways in which these data may be used. We will also discuss in this section limitations of the project. The final section of the report will provide a summary of the project and recommendations for applying these findings and for additional data and monitoring needs.

In a sense we hope this is a progress report rather than a final document. It is our intention that this report will facilitate use of the information system and motivate an interest in maintaining an ongoing data collection and analysis program. It is our hope that the system will be kept current and

and expanded in terms of both the types of information available and in the number and variety of users. We feel the real value of this study is not what we have reported here, but rather in the access and application of these data for decision making.

METHODS

The purpose of this study is not only to determine the level of marina development serving Michigan's Great Lakes but also to establish a monitoring and analysis framework to update and handle these data in the future. The analysis of changes in marina development over a five year time span (1978 to 1983) will give some indication of the dynamic nature of the marina industry. However, the data presented will only be partial observations. Final evaluation of the marina industry cannot be achieved from observations of the relatively short time span of this study or from the few variables collected, but valuable benchmarks are established for further observation in the future. Dr. Luna Leopold suggested the importance of establishing "benchmarks" when he stated at an international conference:

> "The measurement methods described here have their value in time effects, and it is our duty to scientists of the future to provide data that can be compared with conditions found by them at their time. The long-range importance of documentation has been realized by many, but few are willing to invest time and work now for the use of future scientists." (Miller and Leopold, 1963).

Thus the methods used in this study were selected not only to provide comparable data but also to establish a system to which new data may be added and analyzed.

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. Several methods for defining a marina were considered during the early stages of the study. Previous inventories of marinas in Michigan and elsewhere were consulted to arrive at a consensus of what facilities constitute a marina (Fridgen, Table and Gillings, 1981; Crompton, Beardsley, and

Ditton, 1976; Waterways Division, MDNR, 1977; Michigan Department of Transportation, 1982). Literature was reviewed to determine what was needed in the way of supply data, which would be meaningful in the overall analysis of recreation boating in Michigan (Stynes, et al., 1983; Stynes and Holecek, 1980; Stynes and Safronoff, 1981; Michigan Land Use Classification and Referencing Committee, MDNR, 1976). Finally, those agencies funding the study were consulted in order to crystalize their needs (Lester Nichols and Dave Olsen, Waterways Division, 1983: Michael Scieszka and Mark Feldhauser, Land Resource Programs Division, 1983; Larry Karnes, Department of Transportation, 1982).

In looking at definitions of marinas used in previous inventories, it was concluded each was unique. The definitions used were developed based on the individual objectives, limitations, and constraints of each inventory. No two inventories defined a marina in the same way, and one inventory report includes no definition at all. Definitions ranged from a facility offering wet storage for 10 or more pleasure boats providing direct access to given bodies of water to a facility storing water craft with at least one wet storage space with access to any navigable waters.

It is always helpful in the design of research to look at what has come before. However, in the final analysis, one must meet specified objectives of a client or group of users of the data being collected. Clients' objectives must be matched with methodological limitations and budgetary constraints placed on the project. Definitions formulated for this inventory resulted from a combination of existing marina definitions, boating research needs, and agencies' objectives. The derived definition does not satisfy all the requirements of a comprehensive recreational boating analysis. However, it does meet the short term objectives of the funding agencies, is compatible with resources available for this study, and is scientifically sound. Criteria we selected for including marinas in our inventory consisted of number and type

of moorings available, political boundaries, and access to the Great Lakes.

Inventory

To attempt an inventory of a resource which is as extensive, diverse and dynamic as Michigan's Great Lakes marina industry, one must rely on methods which are suited to the task. Other very detailed marina studies have been completed using field inspections and/or mail questionnaires. Neither approach has proven to be satisfactory because resulting inventories contained numerous inaccuracies.

There are several reasons for seeking an alternative to a field inspection inventory approach. First, there are over 3200 miles of Michigan Great Lakes shoreline and many more miles of rivers providing access to the Great Lakes. A field inspection would require travelling this entire coastline to visit all possible marina locations. When one realizes that every road (which might provide access to a marina) would have to be inspected, the immensity of a systematic field inspection and the high probability of error becomes apparent. In addition the coastline is dotted with hundreds of developed and undeveloped islands. Visiting each marina by boat would be feasible; however, this would be very costly and time consuming. Finally, collecting the required data even after locating a marina is not necessarily a simple task and is quite time consuming.

The mail questionnaire method was categorically discarded for, by definition, an inventory is a census of available resources. Since no complete listing of Great Lakes marinas existed, directing questionnaires to all of them was impossible. Furthermore, obtaining a 100% rate of return was deemed impossible and accuracy of data provided could not have been assured.

Due to limitations of field survey and mail questionnaire methods, aerial photographs were selected as the basis for data collection for this study. This approach also has limitations, which will be noted, but it is superior to the field collection approach for several reasons. Three of these reasons

are: 1) photographs provide a permanent, accurate record; 2) this record can be obtained at a relatively low cost; and 3) data can be collected in a relatively short time frame.

1983 Inventory

Our first objective was to collect a current inventory of marinas serving Michigan's Great Lakes. This inventory was collected primarily from a current set of low oblique aerial photographs. On the surface, this method seems fairly straight forward. However, there are several difficulties which had to be overcome in obtaining and interpreting these photographs. These difficulties will be discussed in this section as we present the specific steps taken in obtaining the 1983 marina inventory.

The current 1983 inventory was collected from a set of low oblique aerial photographs taken during the summer boating season. (June-September) Prior to flying the coastline and rivers having access to the Great Lakes, flight planning was necessary. Known marina locations were marked and numbered on United States Geological Survey (USGS) map sheets. These locations were taken from high altitude color infrared photographs taken over a period from 1977 to 1980. The bulk of these photographs were taken in 1978. These maps were then used to direct the flights and insure, to a reasonable degree, marinas would not be missed in fly overs. A five hour flight duration for the pilot and the photographer was found to be optimal, and these maps were used to estimate flight duration. This map set consists of 122 separate sheets and an index. The maps are arranged in a logical geographical order rather than alphabetical order to facilitate locating and refiling maps in flight.

On several occasions new marinas were spotted from the air. Their locations were marked on the appropriate map sheets and the identification numbers for the photographs were recorded adjacent to each location.

Flights were taken in a Cessna Skyhawk. This airplane has a wing-over design which is ideal for unobstructed photography. The flight operations were handled by a minimum of three persons, a pilot, a photographer, and a coordinator-navigator. When flights were in areas with heavy air traffic two pilots were used; one to pilot the aircraft and one to communicate with the air traffic controller and to spot traffic in the vicinity. This arrangement worked well for minimizing the anxiety levels of the crew.

In order to properly position the aircraft, it was necessary that the pilot have a clear understanding of the photographic requirements of the project was well as knowledge of various restrictions placed on airspace around the state. The pilot and the coordinator communicated during the photographing of marinas via a set of hand signals. This allowed the pilot to be instructed as to when and how he should maneuver the plane into an optimal position for the photographer. Just before the plane was in position, the coordinator would indicate to the photographer which marina to shoot. In most cases this was obvious, but where marinas were clustered, groups of marinas were photographed at once. Overlap between frames was necessary to ensure complete coverage of each of the clustered marinas. Photographs of these areas were sorted out later, once they could be carefully studied on the light table.

To take suitable aerial photographs of the marinas the photographer had to be aware of the photographic interpretation needs of the project. All facilities to be inventoried had to be visible. The most difficult task was to simultaneously minimize glare, to shoot when the view was unobstructed by trees and to insure that the entire marina was in the frame. To minimize difficulties with changing film and to insure against equipment failures,

at least two cameras were taken on each flight. These were 35mm SLR cameras, each equipped with a 50mm lens. Photographs were taken using Kodak Kodachrome 64 ASA slide film. Photographs were slightly underexposed to produce a denser image, which made interpretation easier.

The coordinator-navigator had the responsibility of directing the flight, locating the marinas to be photographed, and keeping a log of all the photographs taken. To help document the photography, photographs were taken of identification cards. These cards recorded on the film the roll number, the date, the area of the state, the marinas, and the 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 made the job of identifying the slides after processing much easier.

Each marina was located from the air by the navigator through the use of the USGS map sheets. The pilot was directed to a specific portion of the coastline and the flight path progressed parallel to the coast. When a marina was encountered, a circling maneuver was executed to allow for near vertical photographs. By circling the marina the photographer also had an opportunity to get the best shot possible.

Following each flight, the slides were processed, inspected for suitability, and cataloged. The processing was standard Kodak processing for Kodachrome 64 ASA slide film. The first step in the slide inspection procedure consisted of ensuring that each marinas was, in fact, photographed. Then, each marina slide was inspected to determine if all facilities of interest were visible. The cataloging of the slides included recording on the slide mount the date of the photograph, the photograph identification number (roll, flight and

frame numbers) and the marina's unique identification number.

The final stage of the 1983 inventory process was photograph interpretation and data recording. This interpretation 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.

Interpretation of aerial photographs is the art and science of studying and identifying objects formed as images on photographic film and evaluating their significance. There are several diagnostic characteristics of an image which contributed to our photograph interpretation. Included in these characteristics are: shape, shadow, tone, pattern, texture, association or surroundings with other logically related objects, and size. These attributes of an image, together with the interpretors' knowledge of marinas, lead to identification of variables of interest.

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 (they were present or not) 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 allow for the detail needed in the inventory and since they have been used in previous studies of Michigan marinas.

The 1983 photographs were taken at a low oblique angle. Since the scales of these photographs varied it is difficult, if not impossible, to take measurements from them. Thus, these slip size classes were judged based on estimated sizes of adjacent images, ie. automobiles, parking spaces, or boat types. Use of these "standardized" images constituted our field checks. It is realized this method of measurement is subject to errors due to the variability in the scale of the photographs and the subjectivity of the interpreter. It is felt, however, that these numbers of slips provide a meaningful measure of the relative proportions of the various size classes.

Broadside moorings were recorded in lineal footage of mooring available. Since the same measurement errors apply to both mooring footage and slip sizes, the 1978 vertical aerial photographs were used, whenever possible, to provide a more reliable measure. The measurements from the 1978 photographs are more reliable because there is less scale variation among the various photographs and within the image on each photograph.

Photographs were also taken of groups of buoy moorings. The nearest marina site was assigned a mooring for each buoy recorded on the photograph. We realize without knowledge of specific permit information it is difficult, in some cases, to assign buoys to a given marina. This assignment process was, however, the best approach given we only used the photographs. This at least places the buoys in their proper geographic location for analysis purposes.

Other variables collected relate to the specific location of the marinas. Included in these data are: General Land Office Survey information as to tier, range, and section; the county, the Great Lakes Recreation Boating Regions (Stynes and Safronoff, 1982), and the Great Lake served. These variables were taken from the USGS map sheets and were recorded for subsequent retrieval and analysis purposes.

To summarize, the 1983 marina inventory consists of three elements, which are: the 1983 aerial photographs, the USGS map sheets on which locations of each marina are marked, and the record of what is available at each marina facility. Together these provide a means of analysis for planners and decision-makers to access geographic as well as quantitative data relating to the Great Lakes marina industry. The photographs provide a permanent record of what a specific marina was like in 1983 which can be compared to photographs taken in the past or in the future.

1978 Inventory

The second objective of this study was to compare the 1983 marina development with a previous level of development. One obvious method of approaching this objective would involve a comparison of the 1983 inventory with previously completed inventories. To insure comparability of our data with data from a previous time period, we elected to base the comparison on an inventory of marinas developed from aerial photographs taken of the entire state during 1978. We will discuss here the rationale for selecting aerial photographs as a source of information on previous marina development and then the methods used in producing the 1978 inventory.

A previous unpublished study (Brothers, Kikuchi, Poneleit, and Younger; 1981) compared a portion of the 1977 Waterways Division inventory to counts of marina moorings obtained from the 1978 photographs. They felt that: "Because of discrepancies in the identification of precise marina locations (names and addresses), variations in slip size classes and (many) other unforeseen circumstances, these two inventories were not directly comparable." In fact, of 30 sites inventoried from the 1978 photography, only 17 from the 1977 inventory were somewhat comparable and only 3 of these had the same slip count. The findings of Brothers,et al suggested that a direct comparison between a 1983 aerial photo inventory and an inventory based on the 1978 photographs would be easier and produce the best results.

The 1978 inventory was completed in a very similar manner as the 1983 inventory. The entire Great Lakes coastline of Michigan was examined via the aerial photographs to locate marina development. This process was equivalent to the flight of the coast in 1983 except that, with the complete coverage of the coast available in the 1978 photo set, it was possible to concentrate the 1983 photo flights in areas where marinas were known to exist.

The same types of information which had been recorded for each marina site from the 1983 photographs were noted and recorded from the 1978 photographs. The previously discussed photographic interpretation principles were employed for measurement of the parameters of marinas development in 1978. In addition, land uses of areas adjacent to the marinas were delineated. These land uses were classified using the Michigan Land Cover/Use Classification System, as developed by the Michigan Land Use Classification and Referencing Committee, Land Resource Programs Disvision, Michigan DNR. The 1978 photographs are vertical and of very nearly uniform scale. This allowed land uses to be mapped directly from the photographs using acetate overlays. Land uses were identified to at least second level land use classification codes. In the case of marinas, the fourth level of classification was recorded. These land use maps are to be digitized and placed into the Land Resource Programs Divisions's data storage system.

The 1978 marina inventory includes, then, a set of 1978 aerial photographs on file at Land Resource Programs Division, U.S.G.S. map sheets, marked with marina locations, a record of marina facilities, and a set of acetate overlays which record land uses adjacent to the marina site. The land use maps will eventually be digitized and will be available using computer graphics.

Comparison of Levels of Development

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 interim period, measurement instruments can change radically resulting in vast changes in reliability or accuracy of the data collected. The investigators also become experienced, having been through the measurements once, so they can make adjustments to improve their second set of measurements. Differences between the observations may be due then to changes in measurement instruments or improved expertise rather than true differences in the subject of interest. Our use of aerial photographs from two time periods minimized this instrument and investigator bias.

When previous data has 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 varify data by remeasurement samples has been lost due to changes in the subject of interest over time. Our use of aerial photographs, taken in 1978 and 1983, as data sources for marina information allowed for direct comparisons of images to be made. This eliminated the need for many of the comparability assumptions. We were also able to compare "new" marinas located during the 1983 flights to the 1978 images to insure that these marinas were indeed new rather than missed during the 1978 inventory. Having the old data source available as a reference check which can be remeasured, increased the reliability and accuracy of the comparative analysis.

The comparative analysis was done visually, rather than by counting up all the marina facilities and then comparing the recorded data. If the marinas were determined to be the same on the two photographs, the initial data was assumed to be accurate, and it was duplicated on the second coding sheet. When changes had occurred, the location information was transfered to the second coding sheet. The new photograph was then interpreted and the marina facilities were recorded as they appeared on the 1983 photographs.

This comparison of the two sets of photographs eliminates many of the problems found in other longitudinal studies. It allows for a reliability check and also provides a means for quick data collection when changes have not occurred.

Data Information System

In developing an information system for the marina industry, there are several critical questions which must be asked before objectives for the system can be developed. What decisions will be made using the information system, and what data would be most useful? Where and how will these data be collected? Who will be the user groups of the system? In what format should these data be presented to facilitate use? How will these data be stored and accessed? Should the system be fully automated or are there elements of the data set which are best stored and presented as hard copy? These questions directed both the identification and the development of our objectives for the data information system. We felt that definition of the system and specification of objectives were essential for the information system to be functional and helpful to a variety of users.

In order to define the system and to develop our objectives, we conducted informal interviews with the funding agencies; we looked at two aspects of the agencies' efforts to determine what information was currently being used, and in what form, as well as, how information was currently being collected. These

interviews suggested a model for our information system.

In addition to the technical needs of the funding agencies, we investigated possibilities of using storage and retrieval capabilities of another data system which was already functioning but was not currently being used for marina information. The Land Use Inventory Project, Land Resource Programs Division, currently is in the process of collecting and storing land use information for the entire state. The system is set up to store a variety of information and to display it in graphical or in tabular form. We felt that marina data could be placed in this system where it would serve as just another facet of the Land Use Inventory Projects data base.

In conclusion, our selection of methods used in this study were based on needs expressed by the funding agencies, and the boundaries posed by the constraints and limitations of aerial images. We wanted to provide longitudinal results as soon as possible, and so, compared the current inventory to a set of previous aerial photographs. In effect, we were able to look back in time with complete confidence because the 1978 photographs were available. The main point here is that our methods were designed to provide the funding agencies with something useful very quickly, demonstrating to decision-makers the benefits of continued updates of the information and analysis.

RESULTS

As this project developed, we realized the funding agencies were extremely interested in updating previous marina inventory information, but, more importantly, they needed a system which would: allow for continuous updating of the information, provide various types of analysis capabilities, and retain some flexibility to handle a variety of data sources and applications. As the project matured our objectives crystalized. So, objectives which were stated in the Introduction of this report are slightly different from those stated in our project proposal.

We realized that what the funding agencies and other users of the marina information system really desire is a more complete inventory which meets regulatory requirements and includes additional detail about individual marinas. Provision of this information is beyond the scope and capabilities of methods developed for this project. Therefore, we will present here our findings in terms of the interpretation of the 1978 and 1983 photographs, the information system developed to handle these data, and finally limitations of the study. The limitations will include additional requirements of the information system as well as cautions regarding applications of these results to decision-making.

Definitions

Marinas can and have been defined in a variety of ways. We found in our literature search that nearly every marina study we reviewed defines a marina in a different way, based on the objectives or restrictions of the particular study. We have also formulated our own unique definition of marinas. Criteria used in developing our definition resulted from needs of the funding agencies, limitations of the methods used, and time and budget constraints.

Criteria used to select marinas to be included in our inventories include number and type of mooring facilities available, political boundaries, and access to the Great Lakes. We realize, as should the reader, the arbitrary nature of our criteria for including marinas in this inventory. Marinas inventoried here represent neither the complete marina industry in Michigan nor all mooring opportunities for recreational boating on the Great Lakes. When applying these results to decision-making, one must keep in mind that they are, we believe, very accurate for the component of the total marina system we selected to measure but apply only to that component. Thus, careful attention should be paid to the criteria which follows for including a marina in this inventory.

We defined a marina serving Michigan's Great Lakes as: any facility having at least six wet moorings, located in a Mihcigan County which has Great Lake's shoreline, on navigable waters having access to the Great Lakes and their connecting waters, and down stream from the M33 highway bridge on the Cheboygan River (See Appendix A for upstream limits). The Cheboygan River drains Mullett Lake and provides access from Lake Huron to the inland Waterway, through a series of locks. Marinas on Mullett, Burt, and Crooked lakes were not included in these inventories.

Wet moorings included finger docks, broadside mooring, and buoy mooring. Finger docks generally provide mooring for two boats, one on each side. We deviated from this definition in two situations. Only one mooring was counted where finger docks were spaced such that only one boat could be moored between the two docks, and on the last dock in a row where the outside of the dock was toward open water. In some cases this end mooring was considered broadside mooring rather than slip mooring.

Broadside mooring was interpreted by identifying images of docks or seawalls on the photographs and by measuring their length. A twenty-five foot mooring was used as a minimum for single broadside mooring. This minimum required that a facility, which provided only broadside mooring, have at least

150 feet of broadside mooring (enough space for 6/25 foot boats) to be included in our inventories. Docks which were not included in any of the mooring categories were those adjacent to launch ramps or haul out facilities. These are used primarily as temporary mooring for loading and unloading and were, therefore, not included in the inventories. This resulted in exclusion of several Public Access Sites from the inventory. Only those having broadside mooring greater than 150 feet or having six moorings of another type, were included in our inventory.

Buoy moorings, white or colored floats near marina facilties, were also inventoried. Due to the fact that hazard, no wake, and a variety of other buoys may also be located near marina facilities, our counts of buoy moorings may be inflated. It should also be noted that gulls may also appear as floating moorings which would also inflate these figures.

In applying these results to decisions concerning marinas serving Michigan's Great Lakes as a whole, one needs to keep in mind there are many boat moorings serving the Great Lakes which do not fall within our definition and so are not included in these data.* Decisions are only as good as the data upon which they are based, and we feel that while these results are limited by our criteria, they serve as a point of departure toward a better understanding of marinas serving Michigan's Great Lakes and their development.

Inventories

Our inventory of marina facilities serving Michigan's Great Lakes resulted in a variety of products. Locations of marinas included in these inventories were marked on USGS map sheets, aerial photographic images taken in 1978 and 1983 of each marina have been cataloged, and facilities at each site were inventoried and stored on computer cards and tape. Results presented in this section of the report will focus on facilities inventoried. Discussion of other

* Single or groups of slips numbering less than six in total account for a large number of moorings around the state.

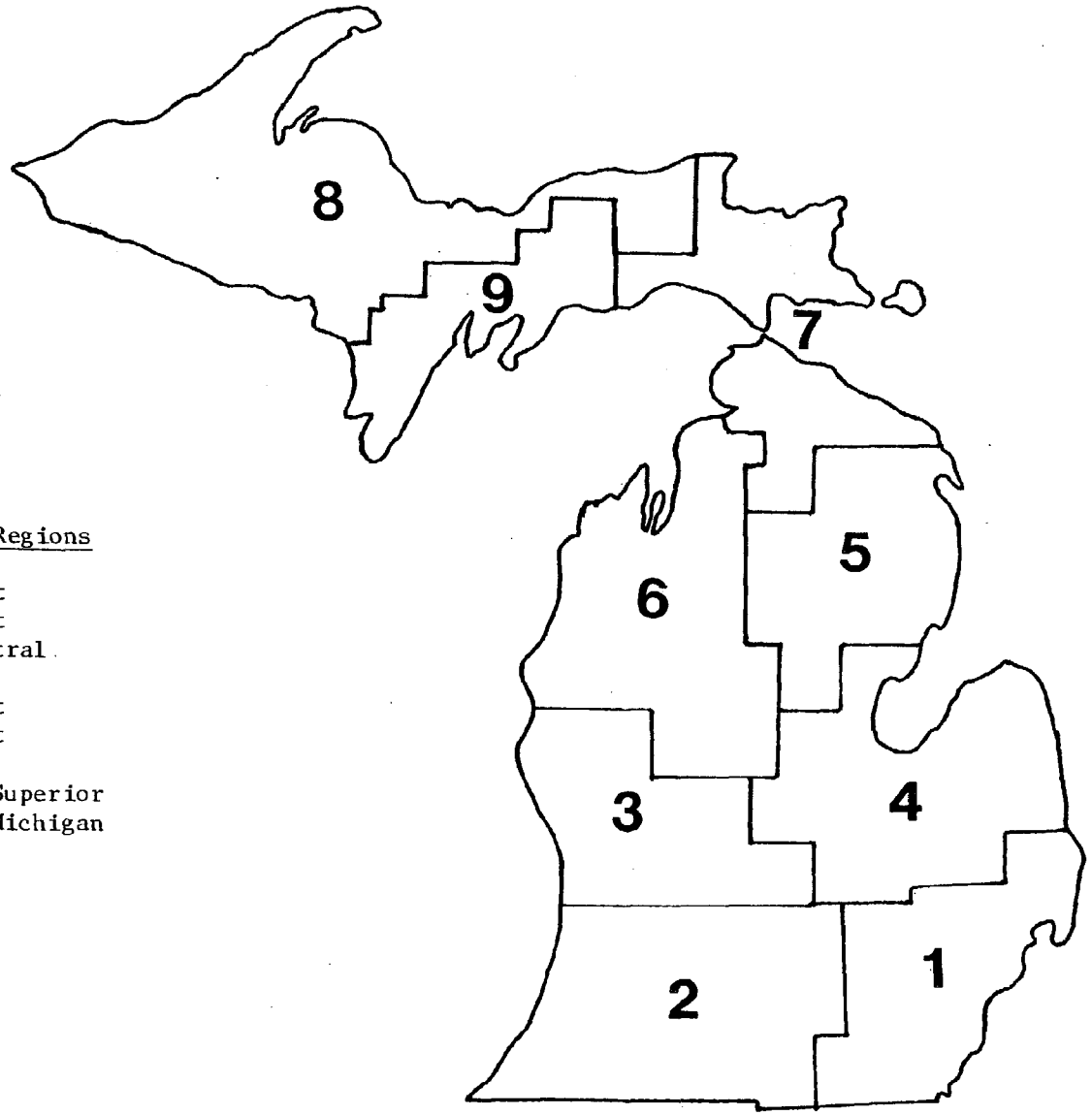
products will be presented in the Data Information System results section of this report. These results will be presented by various geographic regions which are based on political jurisdiction, Great Lake served, and boater behavior. Figure 1 represents the Great Lakes boating regions as presented by Stynes in the 1980 Michigan Recreational Boating Survey (1981). These regions were included in our inventory so our data could be analyzed on the same basis as this earlier boating study. When we refer to Great Lakes boating regions, in the text or on tables, we are refering to the regions presented in Figure 1. These regions were constructed by Stynes and Saffronoff based upon the origins and destinations of Michigan boat owners. Their regions were constructed to minimize boater travel across regions. Thus, the residents within these regions boat primarily within it boundaries.

The number of marinas included in our two inventories (1978 and 1983) are presented in Tables 1, 2, and 3. These tables also show the relative changes in marinas over the past five years. Table 1 shows that the largest number of marinas have been added on Lake Michigan while the greatest percent change was on Lake Erie. The greatest number of marina closings occurred on Lake Huron.

TABLE 1

Comparison of Marinas Inventoried (1978 and 1983) by Great Lake Served

Lake	1978	1983	Change		Net Change
			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
State Total	695	746	60	9	7.3



Great Lakes Regions

1. Southeast
2. Southwest
3. West Central
4. Thumb
5. Northeast
6. Northwest
7. Straits
8. UP Lake Superior
9. UP Lake Michigan

Figure 1. Great Lakes Recreational Boating Regions

Table 2 presents the marinas by the Great Lakes boating regions. These data show that most of the new marinas inventoried were added in the Southeast region of the state. The Southwest region had the largest percent change in marinas inventoried.

TABLE 2

Comparison of Marinas Inventoried (1978 and 1983) by Great Lakes Boating Regions

Region	1978	1983	Change opened	Change closed	Net % Change
1. Southeast	270	291	25	4	7.8
2. Southwest	41	47	6	0	14.6
3. West Central	68	74	7	1	8.8
4. Thumb	60	64	6	2	6.7
5. Northeast	16	18	2	0	12.5
6. Northwest	70	79	9	0	12.9
7. Straits	117	117	2	2	0
8. UP Lake Superior	31	34	3	0	9.7
9. UP Lake Michigan	22	22	0	0	0
State Totals	695	746	60	9	7.3

Table 3 lists, by county, the number of marinas which were included in our inventories. St Clair has the largest number of marinas inventoried and ranks second behind Wayne County for new marinas added. Counties achieving the highest percent change did so because their base was small in 1978 and even the addition of a single marina in these counties resulted in a large percent change.

Noticeably missing from this list of Great Lakes Counties is Luce County. Luce County is not represented in our inventory because Great Lakes facilities serving the county fail to meet our criteria for a marina.

TABLE 3

Comparison of Marinas Inventoried (1978 and 1983) by Great Lakes County

County	1978	1983	Change opened	closed	Net Change %
Alcona	1	1	0	0	0
Alger	2	2	0	0	0
Allegan	14	18	4	0	28.6
Alpena	3	3	0	0	0
Antrim	2	2	0	0	0
Arenac	10	10	1	1	0
Baraga	3	4	1	0	33.3
Bay	15	17	3	1	13.3
Benzie	5	7	2	0	40.0
Berrien	11	12	1	0	9.1
Charlevoix	25	29	4	0	16.0
Cheboygan	7	7	0	0	0
Chippewa	62	61	0	1	1.6
Delta	16	16	0	0	0
Emmet	7	7	0	0	0
Gogebic	2	2	0	0	0
Grand Traverse	3	3	0	0	0
Houghton	13	14	1	0	7.7
Huron	29	30	1	0	3.5
Iosco	12	14	2	0	16.7
Keweenaw	5	6	1	0	20
Leelanau	10	11	1	0	10
Mackinac	40	41	2	1	2.5
Macomb	82	85	3	0	3.7
Manistee	18	20	2	0	11.1
Marquette	4	4	0	0	0
Mason	7	9	2	0	28.6
Menominee	3	3	0	0	0
Monroe	27	32	5	0	18.5
Muskegon	20	23	3	0	15.0
Oceana	8	9	1	0	12.5
Ontonagon	2	2	0	0	0
Ottawa	42	42	1	1	0
Presque Isle	3	3	0	0	0
St. Clair	89	94	6	1	5.6
Sanilac	2	3	1	0	50.0
Schoolcraft	1	1	0	0	0
Tuscola	4	4	0	0	0
Van Buren	16	17	1	0	6.3
Wayne	70	78	11	3	11.4
State Totals	695	746	60	9	7.3

A comparison of slippage inventoried from the 1978 and 1983 aerial photographs are presented in Tables 4, 5, and 6. Slippage has increased the most on Lake Michigan while the percent change is greatest for Lake Erie. The slippage has increased the most in the Southeast Great Lakes boating region, as was noted for total marinas. The Northwest and Northeast Great Lakes boating regions are ranked first and second respectively as far as the greatest percent change in slippage development in the state. This high percent change in the northern regions is again due to a small initial base in 1978.

Table 6 shows slippage development by county. Monroe County had the largest increase in total slips with a net increase of 976, followed by Macomb County with 942. Houghton, Alpena, and Menominee Counties all lost slippage between 1978 and 1983. Macomb County has the greatest number of slips with 7,951 followed by 6,116 slips in Wayne County.

Comparing the overall percent change in marinas (7.3) with the statewide percent change in slippage (20.1) indicates the proportion of slips which have been added exceeds the proportion of new marinas. This result is due to the additional slippage added to existing facilities. Approximately 25 percent of the existing marinas were changed in someway between 1978 and 1983, and the bulk of these changes consisted of the addition of slip mooring sites.

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 B. These are listed by Great Lakes served, boating region, and county. In 1978 slips less than 20 feet in length made up the largest segment of the slips inventoried. In 1983 the largest number of slips was 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 (3,318) were in the 20 to 30 feet size class.

TABLE 4

Comparison of Slips Inventoried (1978 and 1983) by Great Lakes Served

Lake	1978	1983	Net Change	% Change
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
State Totals	30511	36651	6140	20.1

TABLE 5

Comparison of Slips Inventoried (1978 and 1983) by Great Lakes Boating Regions

Region	1978	1983	Net Change	% Change
1. Southeast	17615	20564	2949	16.7
2. Southwest	2376	3095	719	30.3
3. West Central	3002	3704	702	23.4
4. Thumb	2633	3212	579	22.0
5. Northeast	578	803	225	38.9
6. Northwest	1720	2530	810	47.1
7. Straits	1950	2053	103	5.3
8. UP Lake Superior	448	479	31	6.9
9. UP Lake Michigan	189	211	22	11.6
State Totals	30511	36651	6140	20.1

Table 6

Comparison of Slips Inventoried (1978 and 1983) by Great Lakes County

County	1978	1983	Net Change	% Change
Alcona	14	14	0	0
Alger	0	0	0	0
Allegan	661	710	49	7.4
Alpena	170	158	-12	-7.1
Antrim	68	68	0	0
Arenac	285	425	140	49.1
Baraga	115	133	18	15.7
Bay	1263	1571	308	24.4
Benzie	97	204	107	110.3
Berrien	1294	1764	470	36.3
Charlevoix	480	719	239	49.8
Cheboygan	213	215	2	0.9
Chippewa	748	808	60	8.0
Delta	119	147	28	23.5
Emmet	377	381	4	1.1
Gogebic	0	0	0	0
Grand Traverse	175	175	0	0
Houghton	177	161	-16	-9.0
Huron	882	883	1	0.1
Iosco	394	631	237	60.2
Keweenaw	4	18	14	350.0
Leelanau	287	417	130	45.3
Mackinac	520	557	37	7.1
Macomb	7009	7951	942	13.4
Manistee	480	629	149	31.0
Marquette	114	114	0	0
Mason	133	342	209	157.1
Menominee	47	41	-6	-12.8
Monroe	1834	2810	976	53.2
Muskegon	938	1122	184	19.6
Oceana	158	171	13	8.2
Ontonagon	38	53	15	39.5
Ottawa	1937	2417	480	24.8
Presque Isle	92	92	0	0
St. Clair	3246	3657	411	12.7
Sanilac	57	187	130	228.1
Schoolcraft	23	23	0	0
Tuscola	146	146	0	0
Van Buren	421	621	200	47.5
Wayne	5495	6116	621	11.3
State Totals	30511	36651	6140	20.1

Comparisons of the broadside moorings inventoried are presented in Tables 7, 8, and 9. Broadisde mooring was inventoried by length and reported here in feet. To calculate an approximate number of available mooring spaces the reported length can be divided by the length of the average boat to be moored. Overall broadside mooring declined in the state (-8.4%). This is likely due to the conversion of broadside mooring to slip moorings at existing marinas.

Broadside mooring by Great Lake served is presented in Table 7. All lakes lost broadside mooring space with Lake Michigan having the greatest length of mooring lost and the highest percent change. Lake Huron has the highest amount of broadside moorings with 34,500 feet. In 1978 Lake Michigan had the most broadside mooring.

TABLE 7

Comparison of Length of Broadside Mooring Inventoried (1978 and 1983) by Great Lake Served

Great Lake	1978 (Feet)	1983	Net Change	% Change
Michigan	36712	31656	-5056	-13.8
Superior	10452	10248	- 204	- 2.0
Huron	35760	34500	-1260	- 3.5
St. Clair	24792	22560	-2232	- 9.0
Erie	7696	6744	- 952	-12.4
State Totals	115412	105708	-9704	- 8.4

Table 8 compares the broadside moorings inventoried by Great Lakes boating regions. The Straits Region was the only region which gained broadside mooring space. The Southeast lost the most broadside moorings while the Northeast had the highest percent change.

Table 8

Comparison of Length of Broadside Mooring Inventoried (1978 and 1983) by Great Lakes Boating Regions

Boating Region	1978	1983	Net Change	% Change
	(Feet)			
1. Southeast	36184	33144	-3040	-8.4
2. Southwest	4152	4090	-62	-1.5
3. West Central	10848	8544	-2304	-21.2
4. Thumb	7960	7128	-832	-10.5
5. Northeast	7584	5340	-2244	-29.6
6. Northwest	11232	10392	-840	-7.5
7. Straits	20232	20520	288	1.4
8. UP Lake Superior	10140	9936	-204	-2.0
9. UP Lake Michigan	7080	6624	-456	-6.4
State Totals	115412	105708	-9704	-8.4

A comparison of broadside moorings by counties is presented in Table 9. Monroe, Houghton and Chippewa Counties all gained broadside mooring space between 1978 and 1983. There were only 12 counties which gained broadside moorings. Seventeen counties lost some of this type of mooring.

The final type of moorings inventoried were buoy moorings. Comparisons of the inventories of buoys serving the Great Lakes are presented in Table 10, 11 and 12. Statewide buoys increased by 24.6%. The greatest portion being added to Lake Michigan (Table 10). The West Central Region had the greatest increase with an addition of 77 buoys (Table 11), 74 of which were added in Muskegon County (Table 12). The Southeast Region has no buoy moorings and over half the Great Lakes counties (26 of 41) have no buoys.

TABLE 9

Comparison of Length of Broadside Mooring Inventoried (1978 and 1983)

by Great Lakes County

County	1978 (Feet)	1983	Net Change	% Change
Alcona	0	0	0	0
Alger	1848	1248	-600	-32.5
Allegan	528	528	0	0
Alpena	624	624	0	0
Antrim	0	0	0	0
Arenac	2208	1752	-456	-20.7
Baraga	192	264	72	37.5
Bay	2248	1584	-664	-29.5
Benzie	840	936	96	11.4
Berrien	1320	1296	-24	-1.8
Charlevoix	2400	2736	366	15.3
Cheboygan	1608	1608	0	0
Chippewa	8952	9480	528	5.9
Delta	5544	5016	-528	-9.5
Emmet	2136	1752	-384	-18.0
Gogebic	1296	1296	0	0
Grand Traverse	1128	1128	0	0
Houghton	1168	1728	560	48.0
Huron	2760	2904	144	5.2
Iosco	6960	4716	-2244	-32.2
Keweenaw	1536	1536	0	0
Leelanau	1536	1248	-288	-18.8
Mackinac	6984	7320	336	4.8
Macomb	9912	10224	312	3.2
Manistee	3624	2520	-1104	-30.5
Marquette	3696	3696	0	0
Mason	1704	1824	120	7.0
Menominee	864	936	72	8.3
Monroe	3480	4080	600	17.2
Muskegon	3528	2952	-576	-16.3
Oceana	2496	2280	-216	-8.7
Ontonagon	404	168	-236	-58.4
Ottawa	5088	3576	-1512	-29.7
Presque Isle	1152	960	-192	-16.7
St. Clair	12720	11352	-1368	-10.8
Sanilac	744	888	144	19.4
Schoolcraft	72	72	0	0
Tuscola	0	0	0	0
Van Buren	2304	2256	-48	-2.1
Wayne	9808	7224	-2584	-26.4
State Totals	115412	105708	-9704	-8.4

TABLE 10

Comparison of Buoy Moorings Inventoried (1978 and 1983)
by Great Lake Served

Great Lake	1978	1983	Net Change	% Change
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
State Totals	497	619	122	24.5

TABLE 11

Comparison of Buoy Moorings Inventoried (1978 and 1983)

by Great Lakes Boating Region

Boating Region	1978	1983	Net Change	% Change
1. Southeast	0	0	0	0
2. Southwest	19	19	0	0
3. West Central	167	244	77	46.1
4. Thumb	10	10	0	0
5. Northeast	0	9	9	
6. Northwest	129	157	28	21.7
7. Straits	91	98	7	7.7
8. UP Lake Superior	4	5	1	25.0
9. UP Lake Michigan	77	77	0	0
State Totals	497	619	122	24.5

TABLE 12

Comparison of Buoy Moorings Inventoried (1978 and 1983)
by Great Lakes Counties

County	1978	1983	Net Change	% Change
Alcona	0	0	0	0
Alger	4	5	1	25.0
Allegan	0	0	0	0
Alpena	0	0	0	0
Antrim	6	6	0	0
Arenac	0	0	0	0
Baraga	0	0	0	0
Bay	0	0	0	0
Benzie	6	15	9	150.0
Berrien	19	19	0	0
Charlevoix	54	59	5	9.3
Cheboygan	0	0	0	0
Chippewa	0	0	0	0
Delta	32	32	0	0
Emmet	64	64	0	0
Gogebic	0	0	0	0
Grand Traverse	0	0	0	0
Houghton	0	0	0	0
Huron	0	0	0	0
Iosco	0	9	9	
Keweenaw	0	0	0	0
Leelanau	63	77	14	22.2
Mackinac	27	34	7	25.9
Macomb	0	0	0	0
Manistee	0	0	0	0
Marquette	0	0	0	0
Mason	0	0	0	0
Menominee	45	45	0	0
Monroe	0	0	0	0
Muskegon	119	193	74	62.2
Oceana	0	3	3	
Ontonagon	0	0	0	0
Ottawa	48	48	0	0
Presque Isle	0	0	0	0
St. Clair	0	0	0	0
Sanilac	10	10	0	0
Schoolcraft	0	0	0	0
Tuscola	0	0	0	0
Van Buren	0	0	0	0
Wayne	0	0	0	0
State Totals	497	619	122	29.5

An estimate was made of the total available moorings inventoried by adding the slips, broadside spaces and bouy moorings. The number of broadside mooring spaces was estimated by dividing the broadside mooring inventoried by 25 feet.* There were 35,624 spaces inventoried for 1978 and 41,498 inventoried for 1983, an increase of 16.4%. In 1978 the slips made up 85.6% of the total while broadside and buoy moorings made up 13.0% and 1.4% respectively. In 1983 slips made up a larger percentage with 88.3% and broadside mooring lost ground making up only 10.2%. The proportion of buoy mooring remained relatively constant over the 5 year time span making up 1.5% of the moorings.

In addition to mooring facilities, information collected from the aerial photographs included launch ramps and haul out facilities, covered and open dry storage, and land based recreational facilities. These variables are nominal and provide location information but are not quantitative in nature. Summaries and comparison of these variables are presented in Appendices C, D, E, F, and G.

In addition to comparing how these facilities have changed in relation to their geographic distribution, it is also of interest to look at the change in the proportion of marinas inventoried providing these services. Table 13 presents these proportions for the two time frames inventoried. All these proportions decreased from 1978 to 1983 except land based recreational facilities which increased 1.01%. This is a small increase; however, it may show the importance of land based recreational facilities associated with marina development.

In this section of our report we have presented summaries of data collected from aerial photographs taken in 1978 and 1983. Tables in this section showed a comparison between the inventories by three different geographic aggregations. 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

* Twenty-five feet was selected for these calculations, however the average size space could be larger or smaller depending on a specific area.

have changed in the past five years.

Inventory results for individual marinas are not presented in this written report but rather will be presented as a separate product. The nature and format of products separate from this report are directly related to the marina information system developed. We will present in the next section a discussion of these products and how each fits into the data information system.

TABLE 13

Proportion of Marinas Providing Each Type of Service Inventoried in 1978 and 1983

Service	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

Data Information System

In this section of our report, we will discuss the development, organization and specific components of the marina data information system. Included in this will be specific objectives of the system, how the products of this study fit into the system, and suggestions as to data needs of the system. In addition, we will cover procedures for accessing these data and for updating and adding additional data to the system.

In organizing and defining our information system, we realize that the scale of use and diversity of users necessitates a multi-dimensional system. We define the marina information system as a structured interacting complex of persons, machines and procedures which facilitate the efficient flow of pertinent information to be used in decision making processes. The most important component of the system is the people working with the information; the decision-makers who will rely on the system to provide reliable information. These are the individuals who will shape the system into a viable tool for decision-making. The system is, by design, more than a storage facility for current marina inventories, and as such, it will serve as a data processing as well as analysis system.

There are four objectives which shaped the structure of the information system. These were developed to address specific needs of the funding agencies, as well as, to accommodate a wide variety of users. The objectives for the system are:

1) To collect a variety of pertinent data from a number of different sources.

2) To process data so the end product is not only accessible but is also useful in decision-making.

3) To store data in such a fashion that it can be easily accessed and updated.

4) To provide users with information in a variety of formats based on individual user needs.

Discussion in this section will flow from these objectives. We will first present a model for the system, based upon these objectives, and then discuss each component of the model.

The model of the marina data information system is illustrated in Figure 2. This figure shows the four major components (data collection and retrieval, processing, storage, and utilization) and the pathways of data and information flow. Data enters the model on the lefthand side, flows through the four components and finally pertinent information flows to users on the righthand side. We present this model as an ideal which can be worked toward, not as something which can be achieved in the near future. Development of a system based on this model assumes a continued interest and involvement by the funding agencies and user groups. Our intention here is to demonstrate how products from this study fit into the model and the types of information which can be generated. This demonstration is to illustrate the potential of the information system; provided the necessary data and resources are made available.

Data Collection

Data collection involves the tasks of developing or locating data relevant to user groups. This function is made up of three clientele services.

The first of these services is generation of primary data. Some results generated from this study fall under this service. Primary data can range from a quick sampling of opinions to a large-scale census, such as was conducted for this study. The attributes which set this type of data apart from others are 1) it is tailored to a specific information need and 2) it is current.

The second data collection service is the assemblage of data which has already been collected by other sources at other times. These data may be in a variety of forms and in some cases may need interpretation or transformation to be useful to potential users. There is a plethora of information which has been collected that could be added to the system which directly or indirectly pertains to the marina industry. The 1978 aerial photographs are one example of utilization of a secondary data source. Other data which should be considered

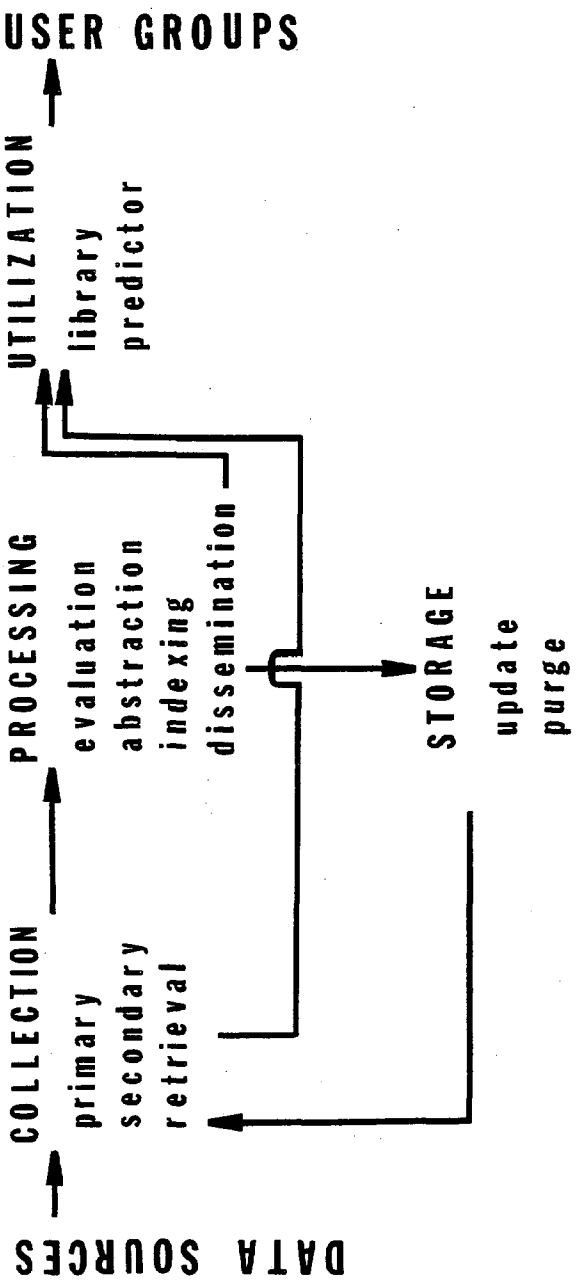


FIGURE 2

Marina Information System Model of Components and Data Flow

for inclusion in the system would be: permit information from divisions of the DNR, names and addresses from a Michigan Sea Grant publication, boat registration data, boat owner survey data, and data from federal agencies concerning harbor maintenance and user permits.

The third data collection service is retrieval. When needed information is already on file, the problem is to locate the data efficiently and in a reasonable time frame. Effective use of the system will hinge on data retrieval techniques adopted by the service agencies. The computer graphics and storage available through Land Resource Programs Division will serve as the primary retrieval center. The Division is currently in the process of writing software for retrieving the data from this study.

Data Processing

Processing data as it enters the system is essential to maintain the overall quality of the system and to enhance the usefulness of particular data. Four major steps can be identified in processing data. The first step in data processing is evaluation. All data entering the system cannot be treated as being equal. Someone with a knowledge of data validation must review data entering the system and offer a technical opinion as to the level of confidence that could be placed in a given set of data. The individual and mechanism used for evaluation will vary with the type of data entered. The level of confidence depends upon methods used in data collection, size of the sample, reliability of sources, and other factors that the data evaluator may deem important. These opinions on the reliability and credibility of information should temper user judgements in making decisions.

The second data processing step is that of data abstraction. Marina data will be collected for this system in a variety of forms and some will be mere

data files with no accompanying report. Decision-makers do not want to read volumes of materials to glean a single kernel of information. Incoming information should be condensed and edited to allow for a sharpening of the data to supply decision-makers with an immediate sense of what is available and what might be relevant to a problem.

The next step in processing incoming data is that of indexing the material. This involves devising a set of descriptors that will permit its efficient classification for storage and retrieval purposes, and a ready identification by which users can pinpoint specific data. For example, the current marina data is identified by geographic descriptors; Great Lake served, boating region, county, and General Land Office Survey, so that users interested in marinas in specific regions can readily select this information. These data will also include file data which must be cross-indexed to the computer system. For example, the 1983 aerial photographs are identified by county, USGS map sheet, and individual marina number. This allows a user who has accessed the computer file of marina data to quickly locate the photographs of interest, or vice versa, the user could access the marina data having identified a marina from the photographic record. Specific identification code and descriptors are presented in Appendix H. Developing a good indexing system is one key to rapid retrieval and dissemination of information.

Dissemination is the final important data processing step. Dissemination is the task of getting information to the right people in the right form in the shortest feasible time. One of the biggest challenges to the coordinating agencies is to make users aware of the marina information system. Among the devices available would be audio-visual presentation to user groups, telephone calls, news releases, and remote computer terminals. The scope of possibilities is only limited by the time and resources devoted to the task and innovation of agency staff involved.

Data Storage

Storage is an important aspect of the information system. With the variety of information types to be stored and the volumes of information which could be anticipated, the storage capabilities must be efficient; otherwise, it will be storage without utility. Users should be able to put their fingers on current as well as historic data with minimum effort. This means efficient storage of computer generated information as well as file materials are needed.

Engineering of an efficient storage system will revolve around the Land Resource Programs' "Land Use Inventory Project" data base. Most of the data from this study will be entered as one component of this existing data base. All the geographic information, including map locations and adjacent land uses, of each marina will be entered in digital form. All the mooring and facility information will also be stored in this system. This eliminates the task of generating extensive software for handling the graphic or statistical output which may be of interest.

As the system matures with the addition of data and updates, it is essential procedures are established to determine the economically desirable life of different types of information. These procedures will guide the periodic updating and purging of information.

Data Utilization

The marina information system must offer more than data collection, processing, and storage services if it is to add leverage to the decision-makers planning and control capabilities. The decision-maker needs basically two types of assistance from the system.

The first type of assistance needed is for information itself. Under this heading fall summaries, in a variety of formats, of data in the system. This could be considered the library of the system, which can output information in useful "report" form. Much of the software which will format these outputs is already in place, however, as new needs are identified software will have to be developed.

The second major area of assistance is in analysis of these data. Initially the level of analysis will be limited to various correlations of the two marina inventories. As the data base expands however, it should develop into a predictor type system of analysis. The system would enable decision-makers to ask "what if" type questions - e.g., "what if 100, 30 feet slips were added in harbor X?" This type of information system is based on mathematical relationships and correlations. To develop such a system, the data base must be expanded and a clearer picture or model must be developed of the marinas serving the Great Lakes.

In this section, we have presented a rather idealistic model for establishing a marina information system. We feel the objectives of the system not only serve the needs of the agencies which have funded this study but also a more diverse group of potential users. Planning of marina facilities in the past has been done without such an information system, and it will continue if the system is not structured and maintained as we propose here. However, we feel with such a system at their disposal, decision-makers will recognize the leverage it affords and by using the system at least become more informed when making their decisions. By design, the system outlined here should fill the need for an information system which reduces data to a point where they can be used in reaching a decision. Yet in setting up the system, care must be taken not to just deal in averages; the true significance may lie in the variations around the mean. Therefore, it is more meaningful to say that the marina information system should reduce and compact data while keeping decision-makers sensitive to variations in the industry. Establishing the information system, as we have outlined here, will take a considerable effort beyond products of this study. We hope we have provided here an idea of the effort in time and resources which will be needed to establish the system.

Limitations of the Study

A review of the results of this study, in light of the objectives stated in the Introduction, illustrates we have provided the funding agencies with a set of products which correspond with our initial intentions. However, this review also points to several areas of the study which are limiting. In this section we will discuss some of the more obvious limitations in hopes of directing users to appropriate and away from inappropriate application of these data. We also hope this discussion will foster innovations in improving subsequent updates of these data and stimulate further expansion of the marina information system. These limitations will be handled in two sections; the first on limitations of the methods and data collected and the second on 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 only be minimized by controlling the data collection with built-in verification checks. Strict adherence to these procedures is the best insurance against excessive rates of error. Technical errors were controlled by double checking data as they were being entered and correlating 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 the 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, we felt we were left with two alternatives. The first was to assume the marina was there, as it was in 1978, or second, that it had been closed since 1978. We felt that since we did fly over the sites and failed to notice marinas to photograph we should consider these two marinas closed.

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

In coding the data, errors in counts of moorings were held to a minimum by cleaning and verifying the coding and keypunching. These data were interpreted from aerial photographs and so are subject to interpreter bias. However, most of the interpretation was done by one person so errors in interpretation, in most cases, will be qualified in our definitions. The best way to verify slip classifications and broadside moorings for each marina would be to do field checks. The time and expense of field checks precluded this from our methodology and therefore reduced the accuracy of these data. However, the total number of slips inventoried, we feel, is very close to the actual figure. This is based on our confidence in the 1983 photographic record and the care taken in their interpretation.

The second area of limitation of this study is in the data which we were unable to collect due to methods used. The aerial photographic record of the marinas is valuable as a tool for current decisions and future comparisons. However, these photographs are lacking in that additional information is essential to the success of the marina information system which cannot be interpreted from them, ie. repair facilities, fuel availability, pump-out facilities, etc.

Funding agencies and other potential users have voiced the need for a correlation of results of this study and names and addresses of the marinas. Other potential users have objected to our definition of marinas serving the Great Lakes as too restrictive. It is their opinion that additional waterways and inland lakes marinas should have been included. These data should be collected and added to the data base.

Our definition of a marina serving the Great Lakes is a limiting factor of this study. Included in this definition are condominium developments which provide mooring facilities to owners of waterfront property. We see no difference in function from the mooring facility a single family property owner might have on a waterfront. There are thousands of single family mooring facilities which have not been included in this study but may be important to questions of recreational boating access. If a user of this study is interested in recreational boating access to the Great Lakes, data collected for this study only provide a portion of the picture.

We have collected a significant set of data, which will serve as a foundation for the marina information system. However, users of these data must be cautioned of limitations of the study which arose from methods used to collect data and data which were not collected.

SUMMARY

Marinas serving Michigan's Great Lakes have expanded both in numbers of marinas and in moorings available during the past five years. The principle aim of this study was documentation of the temporal and spatial nature of this change. We were also concerned with development of a marina information and analysis system which could provide a framework for meaningful planning and policy decisions. In this final chapter, we will summarize our results and conclude with recommendations for further research and development of the proposed marina information system.

Project

A current inventory of marinas serving Michigan's Great Lakes was taken from low oblique aerial photographs shot during the 1983 boating season. This inventory includes 746 marinas, which provide 41,498 moorings.* This represents a 7.3% increase in marinas and a 16.4% increase in moorings in the 5 year period from 1978 to 1983. The majority of this development occurred in the Southeast region of the state, and in the 20 to 30 feet slips size class. These data show that development of slips at existing marinas has contributed most of the new slippage with access to Michigan's Great Lakes.

An analysis of the services we inventoried showed a slightly smaller proportion of all services except the land-based recreation. This suggests that the newer marinas added since 1978 are providing slightly fewer services than marinas in operation during the earlier inventory period. It may also be that some of these services are "developed" as the marina matures and the newer facilities have not reached the point of becoming full service marinas. The

* A portion of these moorings are based on the broadside mooring length inventoried divided by 25 feet per space.

proportion of land based recreation facilities has increased slightly, however, which may indicate the importance of providing on-site recreation facilities.

These data were coded and entered into the Land Resource Programs Division's "Land Use Inventory Project" data system. This data base will serve as a foundation for the automated marina information system. Currently the system includes: marina locations, delineation of adjacent land use polygons, mooring facilities, services and land based facilities, file information on the location of aerial photographs of each marina, and a unique identification number for each marina location. The current system has the capabilities of providing these data in map form; showing the location of marinas, or in tabular form; providing a summary of marina statistics. These data can be recalled at an individual marina level or summarized by various descriptors, ie. geographic or service oriented variables.

Recommendations

This study has initiated a data collection and analysis system for marinas serving Michigan's Great Lakes. There are several suggestions we will make in this section for further development of the system. Additional data which should be included in the information system would improve the range of applications and thus the range of support for the system. Much of this information is available through secondary data sources, however, the problem will be correlation of this additional information with marina locations. To accomplish this task will take cooperation from those agencies and individuals who work with these data and have various additional pieces of data which should be added to the information system.

Names and mailing addresses for marina locations will be essential for many applications of these data. There are several mailing lists available, however, none of these are up-to-date or complete in any sense of the word. Correlation

of the names and addresses with the locations would provide further access to the marinas through questionnaires or telephone interviews. Mailings could also be used to provide a means of verifying data collected from the aerial photographs.

Agencies which permit marina operations, or give approval for development of facilities, will also benefit from having permit identification numbers correlated with marina locations. Sequential aerial photographs can be used to verify existing facilities and questionnaires can then be sent to marinas which have changed. These questionnaires would be used to collect specific data on the nature and extent of changes made.

There are a variety of factors which make marinas serving Michigan's Great Lakes very different from one another. In the application of these data to decision making,these factors should enter into the analysis. One of these factors in the management of the marina. There are six obvious management types which would be useful to include in these data: 1) Commercial, 2) Municipal, 3) State, 4) Club, 5) Private condominium (residence group) 6) Private dockominium (marina group).

Another factor which should be included to distinguish amoung the various types of marinas is the range of service provided by the marinas. These are the services which set marinas apart as far as the boater segments they serve. The marinas which serve power boaters who fish the Great Lakes differ from those marinas which cater to competition class sailboats. Appendix I lists a set of variables which would be important to a variety of boaters.

Finally, to project this information system into a predictive state, these data must be tied to the boater population which uses marinas. We have provided

marina location information in this study. Boat registration information is available from state registration records. We feel these data should be correlated to provide information on the relationship between supply of dockage serving Michigan's Great Lakes and boaters who use it. These supply/demand data could be expanded to include marina attributes which the boater population wants and where they moor their craft. These same attributes could also be inventoried at marinas to determine how well marinas measure up to boater wants and needs.

The additional data collection and information processing and analysis needed to fulfill our recommendations would be a sizable task. However, the benefits of the information would also be tremendous given the wide scope and diversity of potential users. We hope the type of information system we proposed is carried out and can provide a flexible frame work for additional boating related information such as we have recommended here.

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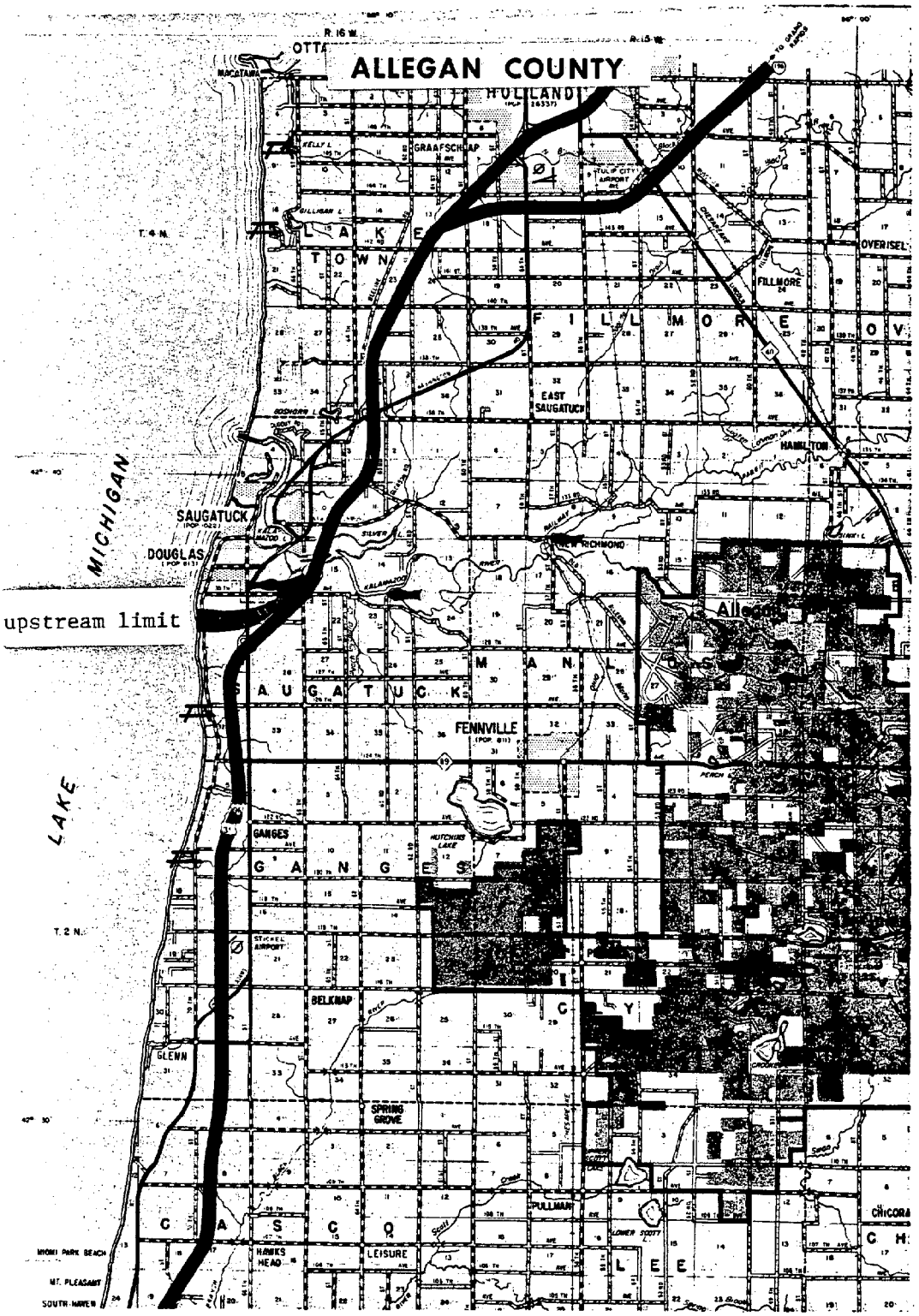
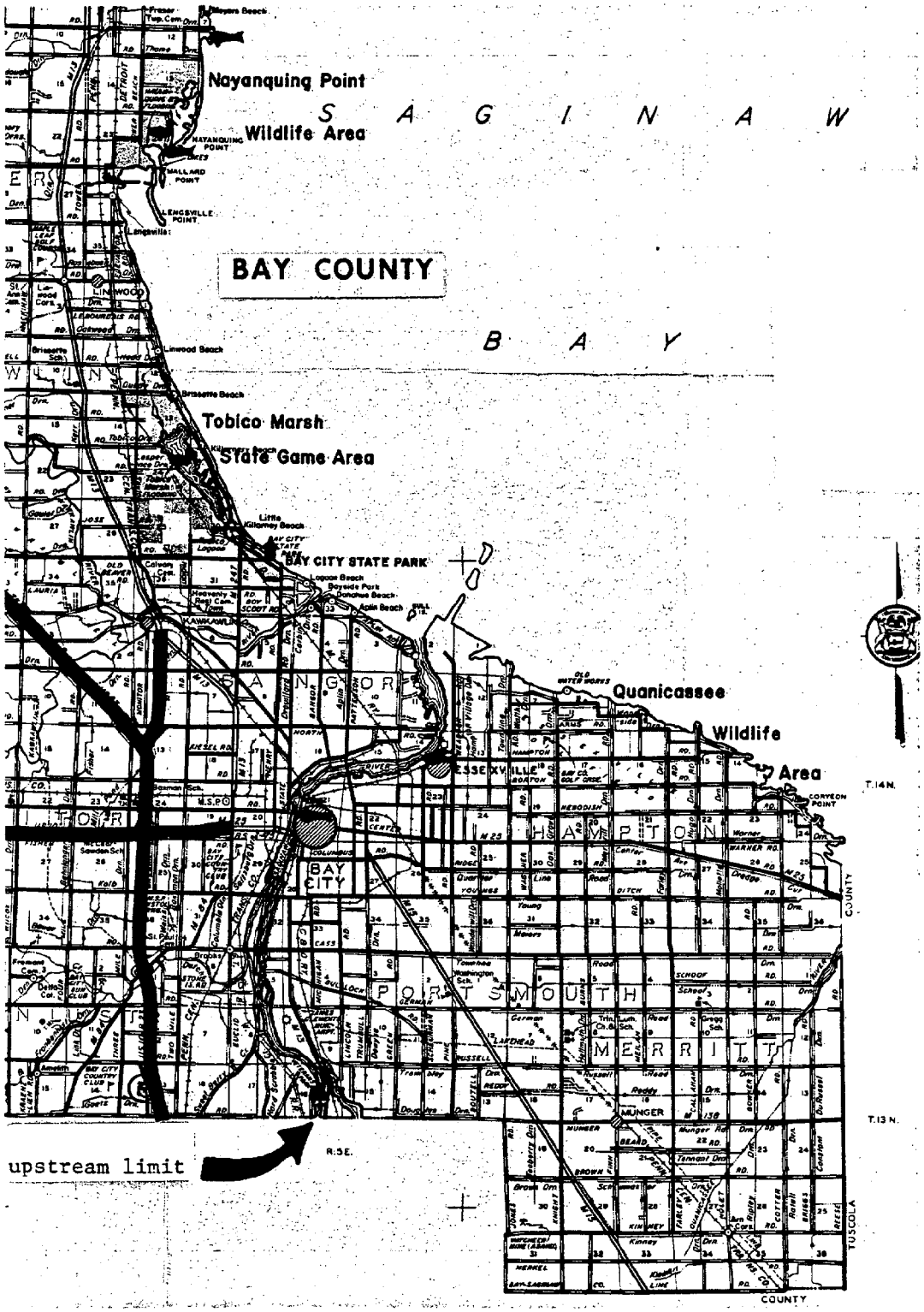
Appendix A

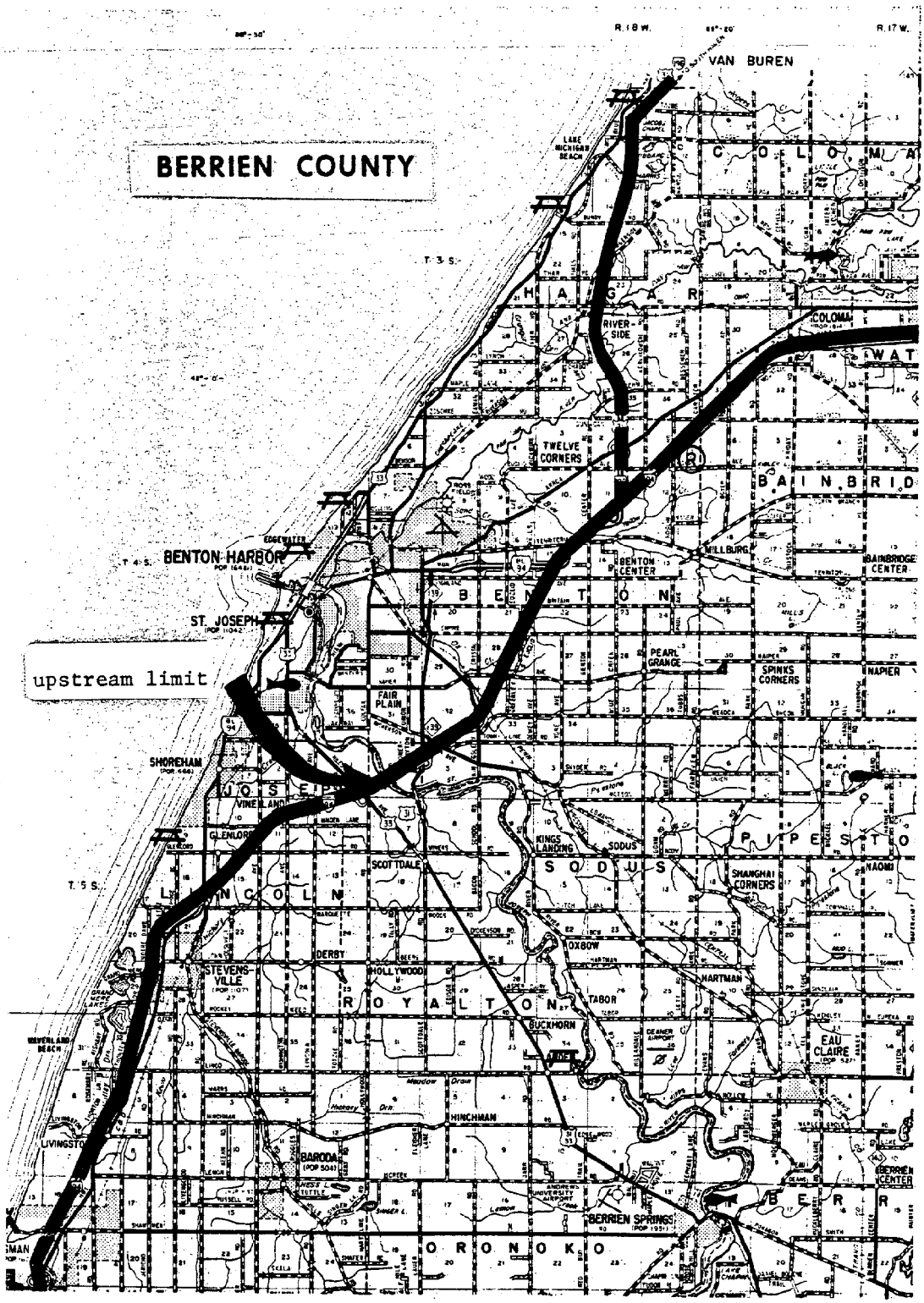
Upstream Inventory Limits on Major Michigan Rivers

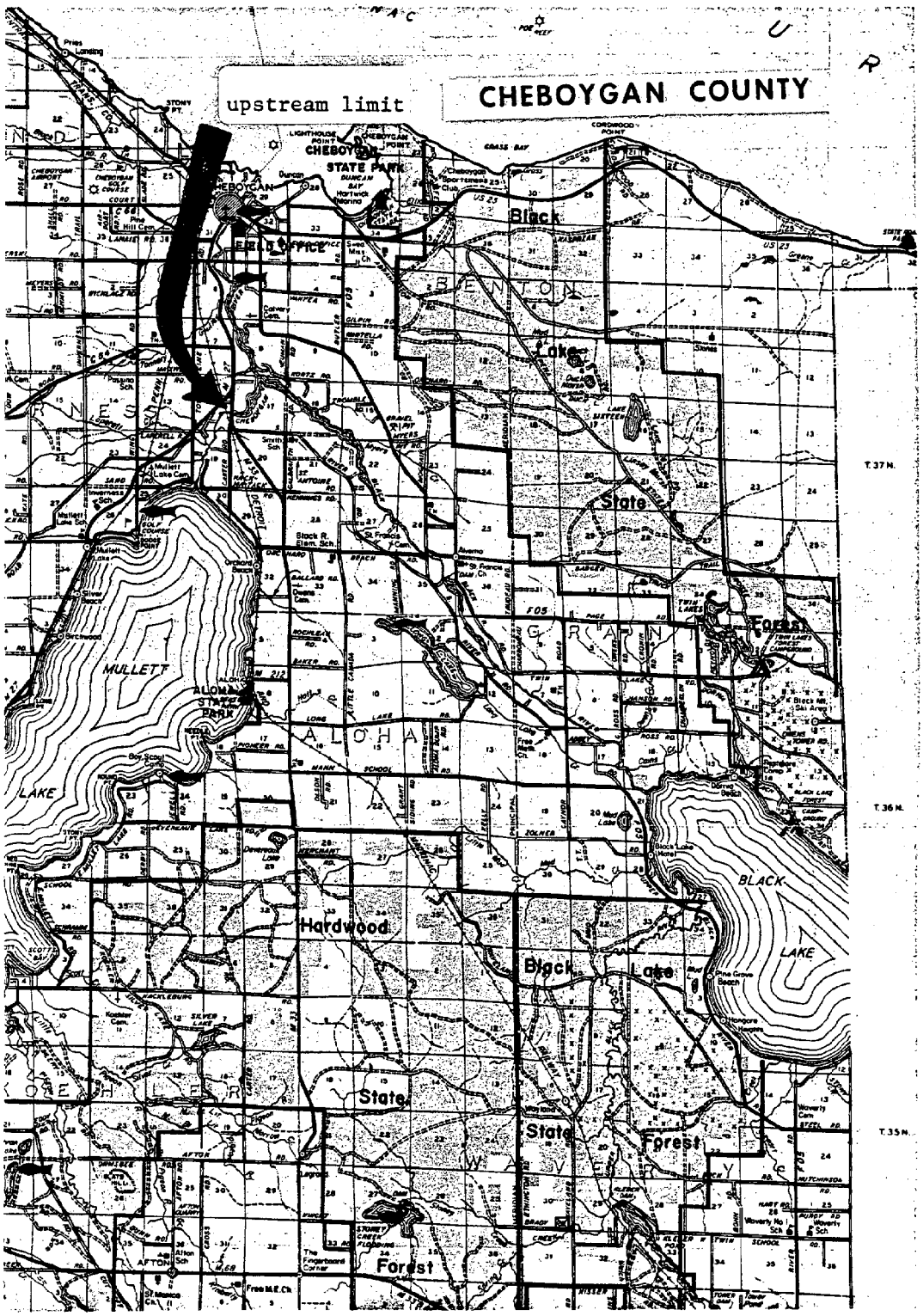
Upstream limits of the following rivers are illustrated on portions of County Maps.

Kalamazoo River, Allegan County
Saginaw River, Bay County
St. Joseph River, Berrien County
Cheboygan River, Cheboygan County
Grand River, Ottawa County
Black River, St. Clair County
River Rouge, Wayne County

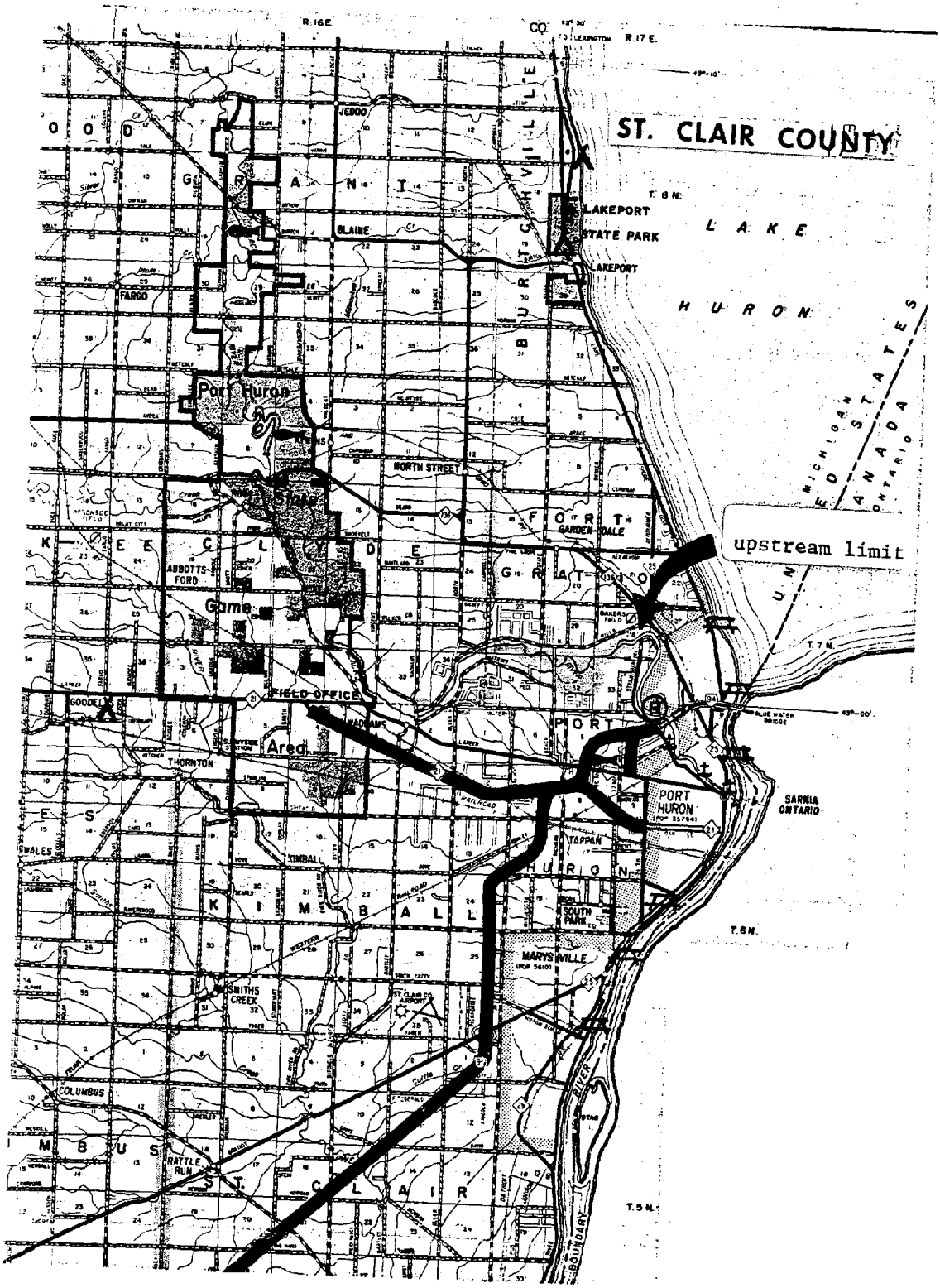

ALLEGAN COUNTY
HOLLAND
GRAAFSCHAP
LAKE TOWN
FILLMORE
EAST SAUGATUCK
OVERISEL
SAUGATUCK
DOUGLAS
MICHIGAN
upstream limit
LAKE
SAUGATUCK
MANLIUS
FENNVILLE
GANGES
CASCO
CLYDE
LEE
BELKNAP
GLENN
SPRING GROVE
PULLMAN
LEISURE
HAMILTON
RICHMOND
T. 4 N.
T. 2 N.
R. 16 W.

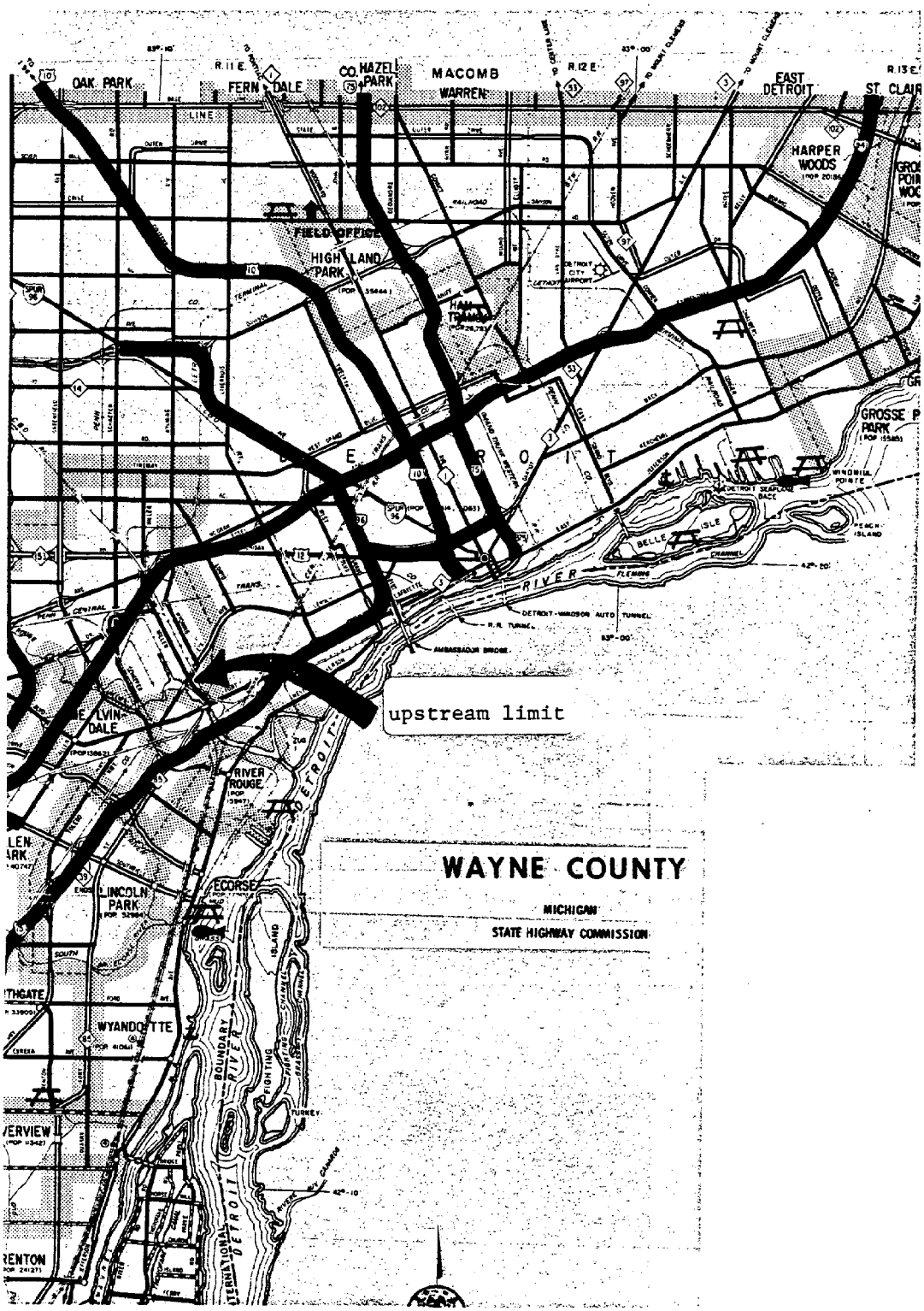

Nayanquing Point
Wildlife Area
SAGINAW
BAY COUNTY
BAY
Tobico Marsh
State Game Area
BAY CITY STATE PARK
Quanicassee
Wildlife
Area
BAY CITY
upstream limit
T.14N.
T.13N.
R.5E.
COUNTY
COUNTY


BERRIEN COUNTY
upstream limit
VAN BUREN
BENTON HARBOR
ST. JOSEPH
SHOREHAM
STEVENSVILLE
BARODA
BERRIEN SPRINGS
BUCHANAN
EAU CLAIRE
COLOMA
RIVERSIDE
TWELVE CORNERS
MILLBURG
BENTON CENTER
BAINBRIDGE CENTER
PEARL GRANGE
SPINKS CORNERS
NAPIER
FAIR PLAIN
KINGS LANDING
SODUS
SHANGHAI CORNERS
NAOMI
OX BOW
HARTMAN
TABOR
BUCKHORN
HINCHMAN
DERBY
HOLLYWOOD
SCOTTDALE
GLENLORD
VINELAND
LAKE MICHIGAN BEACH
WARREN DUNES
LIVINGSTON
T. 3 S.
T. 4 S.
T. 5 S.
R. 18 W.
R. 17 W.
B E N T O N
S O D U S
L I N C O L N
R O Y A L T O N
O R O N O K O
P I P E S T O
B A I N B R I D
C O L O M A
H A G A R
B E R R I


upstream limit
CHEBOYGAN COUNTY
CHEBOYGAN
STATE PARK
FIELD OFFICE
Black
Lake
State
Forest
MULLETT
LAKE
ALOMA
STATE
PARK
Hardwood
Black Lake
State
Forest
State
Forest
BLACK
LAKE
T.37N.
T.36N.
T.35N.


OTTAWA COUNTY
MUSKEGON
FRUITPORT
R. 16 W.
R. 15 W.
R. 14 W.
SPRING LAKE
FERRYSBURG
CROCKERY
POLK
GRAND HAVEN
Grand Haven
State Some Areas
upstream limit
ROBINSON
EAST
ALLENDALE
NORTH BLENDON
BLENDON
HOLLAND
PARK
CRISP
BORCULO
OLIVE
WEST OLIVE
PORT SHELDON
SHELDON
NEW HOLLAND
ZEELAND
PINE CREEK CORNERS
OAKLAWN BEECHWOOD
LAKE SHORE TERRACE
CAMP - BLODGETT
CAMP Mc CARTHY
ZWEMER BEACH
OLIVE HILLS
MOUNTAIN BEACH
PORT SHELDON
ROSABELLE BEACH
VENTURA BEACH
BUCHANAN BEACH
TENNESSEE BEACH
T. 7 N.
T. 6 N.
T. 5 N.


ST. CLAIR COUNTY
LAKE HURON
upstream limit
Port Huron
Marysville
Sarnia Ontario
Lakeport State Park
Lakeport
Fargo
Blaine
North Street
Abbotts-ford
Game
Field Office
Thornton
Timball
Smiths Creek
Columbus
Rattle Run
Garden Dale
Baker's Field
Blue Water Bridge
Port Huron
Tappan
South Park
St. Clair Co. Airport
St. Clair River
Boundary
United States
Canada
Michigan
Ontario
R.16E.
R.17E.
T.8N.
T.7N.
T.6N.
T.5N.


upstream limit
WAYNE COUNTY
MICHIGAN
STATE HIGHWAY COMMISSION
OAK PARK
FERNDALE
HAZEL PARK
MACOMB
WARREN
EAST DETROIT
ST CLAIR
HARPER WOODS
FIELD OFFICE
HIGHLAND PARK
DETROIT
GROSSE PARK
BELLE ISLE
RIVER
DETROIT-WINDSOR AUTO TUNNEL
AMBASSADOR BRIDGE
LINCOLN PARK
RIVER ROUGE
WYANDOTTE
ECORSE
BOUNDARY
INTERNATIONAL

Appendix B

Comparison of Slips Inventoried (1978 and 1983) by Various Size Classes

Comparison of Slips Inventoried (1978 and 1983)

by Size Class and Great Lake Served

Great Lake	1978	1983	Net Change	% Change
		Less Than 20 Feet		
Michigan	2922	3055	133	4.6
Superior	181	167	-14	-7.7
Huron	2178	2236	58	2.7
St. Clair	5130	5371	241	4.7
Erie	1471	1916	445	30.3
State Totals	11882	12745	863	7.3
		20 to 30 Feet		
Michigan	2549	3715	1166	45.7
Superior	150	186	36	24.0
Huron	1796	2477	681	37.9
St. Clair	4662	5399	737	15.8
Erie	1769	2467	698	39.5
State Totals	10926	14244	3318	30.4
		30 TO 40 Feet		
Michigan	1227	1974	747	60.9
Superior	69	63	-6	-8.7
Huron	764	1046	282	36.9
St. Clair	2054	2365	311	15.1
Erie	581	740	159	27.4
State Totals	4695	6188	1493	31.8

Greater than 40 Feet

Michigan	1032	1250	218	21.1
Superior	70	85	15	21.4
Huron	675	705	30	4.4
St. Clair	1071	1199	128	12.0
Erie	160	235	75	46.9
State Totals	3008	3474	466	15.5

Comparison of Slips Inventoried (1978 and 1983)

by Size Class and Great Lakes Boating Region

Boating Region	1978	1983	Net Change	% Change
Less than 20 Feet				
1. Southeast	6687	7368	681	10.2
2. Southwest	1050	1272	222	21.1
3. West Central	973	859	-114	11.2
4. Thumb	997	1008	11	1.1
5. Northeast	285	325	40	14.0
6. Northwest	593	627	34	5.7
7. Straits	1042	1048	6	0.6
8. UP Lake Superior	168	154	-6	-3.6
9. UP Lake Michigan	87	84	-3	-3.4
State Totals	11882	12745	863	7.3
20 to 30 Feet				
1. Southeast	6758	8326	1568	23.2
2. Southwest	523	868	345	66.0
3. West Central	1216	1569	353	29.0
4. Thumb	976	1338	362	37.1
5. Northeast	120	232	112	93.3
6. Northwest	703	1152	449	63.9
7. Straits	437	511	74	16.9
8. UP Lake Superior	150	186	36	34.0
9. UP Lake Michigan	43	62	19	44.2
State Totals	10926	14244	3318	30.4
30 to 40 Feet				
1. Southeast	2828	3325	497	17.6
2. Southwest	337	442	105	31.2
3. West Central	502	868	336	66.9
4. Thumb	317	500	183	57.7
5. Northeast	72	147	75	104.2
6. Northwest	254	515	261	102.8
7. Straits	283	289	6	2.1
8. UP Lake Superior	63	57	-6	-9.5
9. UP Lake Michigan	39	45	6	15.4
State Totals	4695	6188	1493	31.8

Greater Than 40 Feet

1.	Southeast	1342	1545	203	15.1
2.	Southwest	466	513	47	10.1
3.	West Central	311	408	97	31.2
4.	Thumb	343	366	23	6.7
5.	Northeast	101	99	-2	-2.0
6.	Northwest	170	236	66	38.8
7.	Straits	188	205	17	9.0
8.	UP Lake Superior	67	82	15	22.4
9.	UP Lake Michigan	20	20	0	0
	State Totals	3008	3474	466	15.5

Comparison of Slips Inventoried (1978 and 1983)
by Size Class and Great Lakes County

County	1978	1983	Net Change	% Change
		Less Than 20 Feet		
Alcona	0	0	0	0
Alger	0	0	0	0
Allegan	178	200	22	12.4
Alpena	18	6	-12	-66.7
Antrim	44	44	0	0
Arenac	222	271	49	22.1
Baraga	66	54	-12	-18.2
Bay	182	188	6	3.3
Benzie	2	9	7	350.0
Berrien	659	850	191	29.0
Charlevoix	168	159	-9	-5.4
Cheboygan	46	48	2	4.4
Chippewa	518	515	-3	-0.6
Delta	81	84	3	3.7
Emmet	165	152	-13	-7.9
Gogebic	0	0	0	0
Grand Traverse	57	57	0	0
Houghton	50	34	-16	-32.0
Huron	539	492	-47	-8.7
Iosco	267	319	52	19.5
Keweenaw	0	14	14	
Leelanau	36	26	-10	-27.8
Mackinac	301	321	20	6.6
Macomb	3025	3279	254	8.4
Manistee	249	295	46	18.5
Marquette	39	39	0	0
Mason	37	49	12	32.4
Menominee	6	0	-6	-100
Monroe	823	1229	406	49.3
Muskegon	485	501	16	3.3
Oceana	59	49	-10	-17.0
Ontonagon	13	13	0	0
Ottawa	460	327	-133	-28.9
Presque Isle	12	12	0	0
St. Clair	1081	1052	-29	-2.7
Sanilac	10	13	3	30.0
Schoolcraft	0	0	0	0
Tuscola	44	44	0	0
Van Buren	213	222	9	4.2
Wayne	1727	1778	51	3.0
State Totals	11882	12745	863	7.3

Comparison of Slips Inventoried (1978 and 1983)
by Size Class and Great Lakes County (Continued)

County	1978	1983	Net Change	% Change
		20 to 30 Feet		
Alcona	0	0	0	0
Alger	0	0	0	0
Allegan	54	54	0	0
Alpena	4	4	0	0
Antrim	12	12	0	0
Arenac	30	120	90	300.0
Baraga	49	73	24	49.0
Bay	608	781	173	28.5
Benzie	87	121	34	39.1
Berrien	329	492	163	49.5
Charlevoix	118	217	99	83.9
Cheboygan	95	95	0	0
Chippewa	149	212	63	42.3
Delta	24	43	19	79.2
Emmet	62	62	0	0
Gogebic	0	0	0	0
Grand Traverse	107	107	0	0
Houghton	44	44	0	0
Huron	238	243	5	2.1
Iosco	116	228	112	96.6
Keweenaw	4	4	0	0
Leelanau	117	271	154	131.6
Mackinac	109	120	11	10.1
Macomb	2524	3046	522	20.7
Manistee	168	254	86	51.2
Marquette	50	50	0	0
Mason	94	182	88	93.6
Menominee	8	8	0	0
Monroe	739	1172	433	58.6
Muskegon	305	388	83	27.2
Oceana	45	48	3	6.7
Ontonagon	3	15	12	400.0
Ottawa	866	1121	255	29.4
Presque Isle	22	22	0	0
St. Clair	1288	1567	279	21.7
Sanilac	4	98	94	2350.0
Schoolcraft	11	11	0	0
Tuscola	96	96	0	0
Van Buren	140	322	182	130.0
Wayne	2207	2541	334	15.1
State Totals	10926	14244	3318	30.4

Comparison of Slips Inventoried (1978 and 1983)
by Size Class and Great Lakes County (Continued)

County	1978	1983	Net Change	% Change
		30 to 40 Feet		
Alcona	0	0	0	0
Alger	0	0	0	0
Allegan	102	127	25	24.5
Alpena	63	63	0	0
Antrim	0	0	0	0
Arenac	7	16	9	128.6
Baraga	0	6	6	
Bay	225	347	122	54.2
Benzie	8	48	40	500.0
Berrien	231	304	73	31.6
Charlevoix	114	228	114	100.0
Cheboygan	55	55	0	0
Chippewa	69	68	-1	-1.4
Delta	14	20	6	42.9
Emmet	87	96	9	10.3
Gogebic	0	0	0	0
Grand Traverse	11	11	0	0
Houghton	31	31	0	0
Huron	53	83	30	56.6
Iosco	9	84	75	833.3
Keweenaw	0	0	0	0
Leelanau	94	87	-7	-7.4
Mackinac	32	30	-2	-6.3
Macomb	1042	1174	132	12.7
Manistee	27	39	12	44.4
Marquette	16	16	0	0
Mason	0	102	102	
Menominee	25	25	0	0
Monroe	211	298	87	41.2
Muskegon	59	130	71	120.3
Oceana	34	38	4	11.8
Ontonagon	16	4	-12	-75.0
Ottawa	409	700	291	71.1
Presque Isle	40	40	0	0
St. Clair	628	787	159	25.3
Sanilac	26	48	22	84.6
Schoolcraft	0	0	0	0
Tuscola	6	6	0	0
Van Buren	4	11	7	175.0
Wayne	947	1066	119	12.6
State Totals	4695	6188	1493	31.8

Comparison of Slips Inventoried (1978 and 1983)
by Size Class and Great Lakes County (Continued)

County	1978	1983	Net Change	% Change
		Greater than 40 Feet		
Alcona	14	14	0	0
Alger	0	0	0	0
Allegan	327	329	2	0.6
Alpena	85	85	0	0
Antrim	12	12	0	0
Arenac	26	18	-8	30.8
Baraga	0	0	0	0
Bay	248	255	7	2.8
Benzie	0	26	26	
Berrien	75	118	43	57.3
Charlevoix	80	115	35	43.8
Cheboygan	17	17	0	0
Chippewa	12	13	1	8.3
Delta	0	0	0	0
Emmet	63	71	8	12.7
Gogebic	0	0	0	0
Grand Traverse	0	0	0	0
Houghton	52	52	0	0
Huron	52	65	13	25.0
Iosco	2	0	-2	-100
Keweenaw	0	0	0	0
Leelanau	40	33	-7	-17.5
Mackinac	78	86	8	10.3
Macomb	418	452	34	8.1
Manistee	36	41	5	13.9
Marquette	9	9	0	0
Mason	2	9	7	350.0
Menominee	8	8	0	0
Monroe	61	111	50	82.0
Muskegon	89	103	14	15.7
Oceana	20	36	16	80.0
Ontonagon	6	21	15	250.0
Ottawa	202	269	67	33.2
Presque Isle	18	18	0	0
St. Clair	249	251	2	0.8
Sanilac	17	28	11	64.7
Schoolcraft	12	12	0	0
Tuscola	0	0	0	0
Van Buren	64	66	2	3.0
Wayne	614	731	117	19.1
State Totals	3008	3474	466	15.5

Appendix C

Comparison of Launch Ramp Facilities Inventoried (1978 and 1983)

Comparison of Launch Ramp Facilities Inventoried

Great Lake	1978	1983
Michigan	89.0	97.0
Superior	22.0	24.0
Huron	125.0	129.0
St. Clair	70.0	70.0
Erie	36.0	37.0
Boating Region		
Southeast	116.0	116.0
Southwest	9.0	12.0
West Central	31.0	33.0
Thumb	38.0	40.0
Northeast	10.0	12.0
Northwest	33.0	36.0
Straits	73.0	74.0
UP Lake Superior	19.0	21.0
UP Lake Michigan	13.0	13.0

Comparison of Launch Ramp Facilities Inventoried

County	1978	1983
Alcona	1.0	1.0
Alger	2.0	2.0
Allegan	0	0
Alpena	3.0	3.0
Antrim	1.0	1.0
Arenac	8.0	8.0
Baraga	3.0	4.0
Bay	9.0	11.0
Benzie	2.0	2.0
Berrien	3.0	6.0
Charlevoix	10.0	12.0
Cheboygan	5.0	5.0
Chippewa	44.0	44.0
Delta	10.0	10.0
Emmet	2.0	2.0
Gogebic	1.0	1.0
Grand Traverse	1.0	1.0
Houghton	6.0	6.0
Huron	18.0	18.0
Iosco	6.0	8.0
Keweenaw	3.0	4.0
Leelanau	7.0	7.0
Mackinac	21.0	22.0
Macomb	35.0	36.0
Manistee	10.0	10.0
Marquette	3.0	3.0
Mason	2.0	3.0
Menominee	1.0	1.0
Monroe	19.0	22.0
Muskegon	9.0	10.0
Oceana	5.0	5.0
Ontonagon	1.0	1.0
Ottawa	17.0	18.0
Presque Isle	3.0	3.0
St. Clair	31.0	29.0
Sanilac	1.0	1.0
Schoolcraft	0	0
Tuscola	2.0	2.0
Van Buren	6.0	6.0
Wayne	31.0	29.0
State Totals	342.0	357.0

Appendix D

Comparison of Haul Out Facilities Inventoried (1978 and 1983)

Comparison of Haul Out Facilities
Inventoried

Great Lake	1978	1983
Michigan	48.0	55.0
Superior	7.0	7.0
Huron	27.0	29.0
St. Clair	67.0	69.0
Erie	21.0	21.0
Boating Region		
Southeast	93.0	95.0
Southwest	9.0	12.0
West Central	22.0	24.0
Thumb	11.0	13.0
Northeast	4.0	4.0
Northwest	13.0	15.0
Straits	11.0	11.0
UP Lake Superior	6.0	6.0
UP Lake Michigan	1.0	1.0

Comparison of Haul Out Facilities
Inventoried

County	1978	1983
Alcona	0	0
Alger	1.0	1.0
Allegan	3.0	3.0
Alpena	2.0	2.0
Antrim	0	0
Arenac	0	0
Baraga	0	0
Bay	4.0	6.0
Benzie	0	1.0
Berrien	3.0	6.0
Charlevoix	5.0	5.0
Cheboygan	4.0	4.0
Chippewa	2.0	2.0
Delta	1.0	1.0
Emmet	3.0	3.0
Gogebic	0	0
Grand Traverse	0	0
Houghton	2.0	2.0
Huron	5.0	5.0
Iosco	2.0	2.0
Keweenaw	0	0
Leelanau	3.0	4.0
Mackinac	2.0	2.0
Macomb	36.0	37.0
Manistee	4.0	4.0
Marquette	2.0	2.0
Mason	1.0	1.0
Menominee	0	0
Monroe	9.0	10.0
Muskegon	6.0	6.0
Oceana	1.0	1.0
Ontonagon	1.0	1.0
Ottawa	15.0	17.0
Presque Isle	0	0
St. Clair	23.0	22.0
Sanilac	1.0	1.0
Schoolcraft	0	0
Tuscola	1.0	1.0
Van Buren	3.0	3.0
Wayne	25.0	26.0
State Totals	170.0	181.0

Appendix E

Comparison of Covered Dry Storage Facilities Inventoried (1978 and 1983)

Comparison of Covered Dry Storage Facilities Inventoried

Great Lake	1978	1983
Michigan	77.0	77.0
Superior	10.0	10.0
Huron	66.0	67.0
St. Clair	68.0	68.0
Erie	21.0	22.0
Boating Region		
Southeast	97.0	97.0
Southwest	16.0	17.0
West Central	28.0	28.0
Thumb	23.0	25.0
Northeast	9.0	10.0
Northwest	23.0	23.0
Straits	32.0	31.0
UP Lake Superior	8.0	8.0
UP Lake Michigan	6.0	5.0

Comparison of Covered Dry Storage Facilities Inventoried

County	1978	1983
Alcona	0	0
Alger	2.0	2.0
Allegan	6.0	6.0
Alpena	3.0	3.0
Antrim	0	0
Arenac	3.0	3.0
Baraga	0	0
Bay	7.0	9.0
Benzie	2.0	2.0
Berrien	5.0	7.0
Charlevoix	7.0	7.0
Cheboygan	6.0	6.0
Chippewa	15.0	15.0
Delta	4.0	3.0
Emmet	4.0	4.0
Gogebic	0	0
Grand Traverse	1.0	1.0
Houghton	4.0	4.0
Huron	10.0	10.0
Iosco	6.0	7.0
Keweenaw	0	0
Leelanau	3.0	3.0
Mackinac	6.0	5.0
Macomb	34.0	33.0
Manistee	6.0	6.0
Marquette	2.0	2.0
Mason	4.0	4.0
Menominee	1.0	1.0
Monroe	11.0	13.0
Muskegon	9.0	9.0
Oceana	4.0	4.0
Ontonagon	0	0
Ottawa	15.0	15.0
Presque Isle	2.0	2.0
St. Clair	34.0	33.0
Sanilac	2.0	2.0
Schoolcraft	0	0
Tuscola	1.0	1.0
Van Buren	5.0	4.0
Wayne	18.0	18.0
State Totals	242.0	244.0

Appendix F

Comparison of Open Dry Storage Facilities Inventoried (1978 and 1983)

Comparison of Open Dry Storage Facilities Inventoried

Great Lake	1978	1983
Michigan	116.0	122.0
Superior	19.0	20.0
Huron	116.0	120.0
St. Clair	96.0	95.0
Erie	37.0	39.0
Boating Region		
Southeast	142.0	142.0
Southwest	26.0	28.0
West Central	39.0	40.0
Thumb	38.0	42.0
Northeast	12.0	14.0
Northwest	35.0	38.0
Straits	64.0	63.0
UP Lake Superior	16.0	17.0
UP Lake Michigan	12.0	12.0

Comparison of Open Dry Storage Facilities Inventoried

County	1978	1983
Alcona	1.0	1.0
Alger	2.0	2.0
Allegan	9.0	9.0
Alpena	3.0	3.0
Antrim	1.0	1.0
Arenac	6.0	6.0
Baraga	3.0	4.0
Bay	10.0	13.0
Benzie	4.0	4.0
Berrien	6.0	8.0
Charlevoix	8.0	10.0
Cheboygan	6.0	6.0
Chippewa	42.0	42.0
Delta	9.0	9.0
Emmet	4.0	4.0
Gogebic	0	0
Grand Traverse	0	0
Houghton	7.0	7.0
Huron	18.0	19.0
Iosco	8.0	10.0
Keweenaw	0	0
Leelanau	5.0	5.0
Mackinac	12.0	11.0
Macomb	44.0	44.0
Manistee	12.0	13.0
Marquette	2.0	2.0
Mason	5.0	6.0
Menominee	1.0	1.0
Monroe	18.0	21.0
Muskegon	12.0	12.0
Oceana	4.0	4.0
Ontonagon	2.0	2.0
Ottawa	23.0	23.0
Presque Isle	2.0	2.0
St. Clair	43.0	39.0
Sanilac	2.0	2.0
Schoolcraft	0	0
Tuscola	2.0	2.0
Van Buren	11.0	11.0
Wayne	37.0	38.0
State Totals	384.0	396.0

Appendix G

Comparison of Land Based Recreational Facilities Inventoried (1978 and 1983)

Comparison of Land Based Recreational Facilities Inventoried

Great Lakes	1978	1983
Michigan	26.0	32.0
Superior	0	0
Huron	10.0	12.0
St. Clair	24.0	26.0
Erie	1.0	3.0
Boating Region		
Southeast	28.0	32.0
Southwest	5.0	8.0
West Central	7.0	8.0
Thumb	1.0	2.0
Northeast	1.0	1.0
Northwest	7.0	9.0
Straits	9.0	10.0
UP Lake Superior	0	0
UP Lake Michigan	3.0	3.0

Comparison of Land Based Recreational Facilities Inventoried

County	1978	1983
Alcona	0	0
Alger	0	0
Allegan	4.0	6.0
Alpena	0	0
Antrim	0	0
Arenac	0	0
Baraga	0	0
Bay	0	0
Benzie	0	1.0
Berrien	0	1.0
Charlevoix	4.0	4.0
Cheboygan	0	0
Chippewa	3.0	3.0
Delta	2.0	2.0
Emmet	4.0	4.0
Gogebic	0	0
Grand Traverse	0	0
Houghton	0	0
Huron	1.0	1.0
Iosco	1.0	1.0
Keweenaw	0	0
Leelanau	1.0	1.0
Mackinac	2.0	3.0
Macomb	5.0	6.0
Manistee	2.0	2.0
Marquette	0	0
Mason	0	1.0
Menominee	0	0
Monroe	0	1.0
Muskegon	2.0	2.0
Oceana	0	0
Ontonagon	0	0
Ottawa	5.0	6.0
Presque Isle	0	0
St. Clair	6.0	7.0
Sanilac	0	1.0
Schoolcraft	1.0	1.0
Tuscola	0	0
Van Buren	1.0	1.0
Wayne	17.0	18.0
State Totals	61.0	73.0

Appendix H

Code Book for 1978 and 1983 Great Lakes Marina Inventory

VARIABLE NAME	CODE FIELD	CODE
CASE	1 - 4	Sequential numbering of marinas
Aerial Photo Data		
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
AGENCY	20	Agency having control of photos 1 - Land Resources Programs Division 2 - Department of Transportation 3 - Waterways Division 4 - Remote Sensing Program MSU
Location of Marina		
GLSERV	21	Great Lake served by the marina 1 - Michigan 2 - Superior 3 - Huron 4 - St. Clair 5 - Erie
COUNTY	22 - 23	County 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 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

VARIABLE NAME	CODE FIELD	CODE
		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 - 28	Tier of township
RANGE	29 - 31	Range of Township
Marina Facilities		
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
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 actual number
TWTOTH	40 - 42	Slips twenty to thirty feet Code actual number
THTOFO	43 - 45	Slips thirty to forty feet Code actual number
GTFO	46 - 48	Slips greater than forty feet Code actual number

VARIABLE NAME	CODE FIELD	CODE
BSIDE	49-52	Broadside mooring in feet Code actual footage
BUOY	53-54	Buoy mooring
Secondary Data Sources		
MANAGE	55	Management of marina 1 - Commercial 2 - Municipal 3 - State 4 - Club 5 - Other 6 - Unknown
BREGION	56	Great Lakes 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 I

Marina Attributes List

Marina Attributes

These attributes could be included in questionnaires sent to marinas for further inventory data to be included in the information system. They could also be rated by boaters using marinas as to their importance in the decision to rent moorage at a particular marina.

LOCATION ATTRIBUTES

- Close upstream to Great Lakes
- On Great Lakes
- Nearness to residence
- Nearness to good fishing
- Nearness to good sailing waters
- Nearness to scenic areas (coastlines)
- Nearness to other recreational activities not associated with marina (ie. shopping, natural areas, parks)

BOAT OPERATIONS

- Hoist, launch ramp
- Electricity
- Water
- Fuel-gas, diesel
- Pump out
- Radio contact - call letters
- Hours of operation
- Dock help
- Overnight slips
- Seasonal dry storage (covered, open)
- Boat trailer storage
- Marine Supply store
- Maintenance, repair and parts

BOATER SERVICES

- Laundromat
- Party Store
- Ice
- Parking near slips
- Camping, (trailers or tents)
- Showers, bath
- Fishing supplies
- Telephone
- Fish cleaning station
- Landscaped premises
- Recreation facilities (swimming pool, tennis courts, game rooms)