A SYSTEM OF MODELS FOR ESTIMATING RECREATIONAL BOATING USE IN MICHIGAN COUNTIES

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ABSTRACT

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Reliable and timely estimates of the amount and geographic distribution of recreational boating use are important to agencies and businesses that make recreational boating decisions. Currently there is no reliable and cost effective method for predicting the amount or location of recreational boating use without conducting costly surveys. The primary purpose of this study was to develop a system of models which utilizes various secondary data sources to produce reliable boating use estimates at the county level. The modeling approach is different from previous attempts to model boating use in that types (marinas, second homes) and locations of boat storage are key components of the system.

The system of models includes a classification model, boat allocation models, a trip generation model, and trip distribution models. The classification model categorizes registered boats into types of storage segments. The boat allocation models estimate the number of boats in different types of storage that are kept in Michigan counties during the boating season. The trip generation and trip distribution models estimate the number of boat days in the destination counties. The models were estimated using the 1994

Michigan Boating Survey, boat registration data, a Great Lakes marina inventory, and inventories of water resources and boating facilities. The system produces estimates of: the number of boats in different types of storage, the number of boats (in different types of storage) kept in Michigan counties, and the number of boat days in destination counties by boat storage segments.

Compared to survey based estimates, the system provides somewhat more robust estimates of boating use at the county level by incorporating several independent sources of data, and linking various types of models. Linking different models allows the system to generate various types of boating use estimates and also reduces external data requirements. The model produced estimates of boating use mirror the spatial patterns of Michigan boating use. The system of models confirms the predominate "south-to-north" spatial travel patterns observed in previous Michigan boating studies. Model generated estimates of boat days are within 10% of the 1994 survey based estimates for most regions of the state.

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CHAPTER I

INTRODUCTION

Michigan has an abundance of water resources - Great Lakes, inland lakes and rivers - for recreation. The Great Lakes account for 40 percent of the state's 96,791 square miles of surface area. The state has 3,288 miles of Great Lakes coastline which is equal to the length of the Atlantic coast of the United States (D'Itri, 1995). In addition, Michigan has approximately 35,000 lakes that are greater than one-tenth of an acre in surface area, and 36,350 miles of rivers. These water resources support a variety of recreation and tourism activities. Recreational boating is clearly one of the most popular and economically important of these recreational activities.

According to the US Coast Guard, Michigan leads the nation in number of registered watercraft. In December 1994, 901,480 boats were registered in Michigan. Excluding commercial boats and those with expired registrations, approximately 555,000 boats were actively used for recreation (Stynes et al., 1995). It is estimated that during the 1994 boating season, these registered craft logged an estimated 13.4 million boat days, 4.8 million on Great Lakes and connecting waters, and about 8.6 million on inland waters (Stynes et al., 1995).

Recreational boating supports a major industry in Michigan that includes boat builders, boat dealerships, repair services and marinas. In 1993, 20,850 people in Michigan worked in boating-related business including 860 boat dealers and 115 boat

builders (National Marine Manufacturers Association Statistics, 1994). The National Marine Manufacturers Association (1994) estimated $247 million[1] of boat sales in Michigan in 1993. Total boating related sales impact in 1994 (excluding new boat purchases) was estimated to be about $2 billion supporting 50,000 jobs (Stynes et al., 1995).

During the 1960's, 70's and early 80's, participation in recreational boating increased steadily. Efforts to clean up the Great Lakes and reduce water pollution, planting of new fish species (e.g., salmon, steelhead), development of harbors of refuge, additional public access sites and marinas, and increasing disposable income contributed to continued increases in recreational boating "demand" and "supply." However, some evidence exists that boating activities may be leveling off (Stynes et al., 1995). The apparent decrease in boating can be attributed to a combination of factors: reduced catch rate of Great Lakes fish, fish contaminant warnings, and the aging of boaters and the boating fleet.

Planning, management and marketing for recreational boating requires up-to-date information on boating "demand" (amount of use and location of use), as well as the number and distribution of boating facilities. A 1991 recreational boating workshop identified a number of important issues and decisions confronting the boating industry and various management agencies (Mahoney, 1991). Among the most important and potentially contentious issues are: approval and permitting of new boating facilities; development and maintenance of recreation boating facilities; fees and taxes related to boating; the allocation of fuel tax revenues; management of the amount of recreational

[1] The $247 million includes sales of both new boats and used boats.

boating access; regulation of conflicts among types of boaters, and between boaters and other (water-resource) users, and the establishment of a statewide information system to assist in management and marketing plans. In addition, industry associations and boating businesses must develop product and marketing strategies to deal with increasing inactivity and decline in boat use since 1986, increasing vacancies at marinas, the aging of boat owners and the fleet, recruitment of new boaters, and modification and up-grading of existing facilities in response to changes in boaters' preferences and behavior.

PROBLEM STATEMENT

Many boating-related issues, as well as investment, planning, marketing and management decisions require current boating use information such as: number of (active) boats registered in different regions and counties; number of boats stored in regions and counties during the boating season; number of boats stored at marinas, second homes, and permanent homes; the spatial distribution and patterns of storage and movement (e.g., trailering) of boats within the state, and; boating use by different boat(ing) segments. Both public and private sectors require this information for use in policy formation, laws and regulations, facility feasibility assessment, management, and marketing strategies. Although boating data are collected on a regular basis through a variety of means including state-wide boater surveys, special studies, registration data and inventories, planners/managers currently lack the ability to produce reasonably accurate estimates of boating activity in regions and counties without conducting costly large-scale studies. In large part, this is because models that can efficiently utilize secondary

information to estimate and predict boating use on a geographic level compatible with the scope of boating related decisions have not been developed.

Over the last three decades many different studies has been conducted to provide recreational boating information. The studies have included regular surveys of registered boat owners, state-wide and local estimates of use and economic impacts, special boating issues such as carrying capacity, and inventories of boating facilities and resources. Statewide surveys of registered boaters in Michigan have been conducted every 5 to 8 years (1964, 1965, 1968, 1971, 1974, 1980, 1986, and 1995). These surveys generated descriptive information (e.g., days boated that year, where boats are stored and used) providing a snapshot of boating "activities" at those "moments of time".

However, there are problems associated with relying on the results of state-wide boater surveys conducted five to eight years apart. First, the boating market and behavior of boaters are dynamic and significant changes can occur within a five year period. The estimates of boating use based on state-wide boating surveys only reflect boating use situations for a short period of time. Budget cutbacks, competition for available funds, and increased cost of conducting surveys have increased the length of time between state-wide boating studies. Second, even with relatively large sample sizes (e.g., 6,000 for the 1994 Michigan Boating Survey), it still is difficult to estimate or describe local, or even regional boating activity and behavior with a reasonable level of confidence. Many decisions such as proposals for new facilities or regulations require specific and local boating information. Surveys of many more than ten thousand boaters would be necessary to provide accurate estimates of boating activity for different boating segments (size

classes, storage segments) for all eighty-three Michigan counties. Previous boater surveys did not have sufficient sample sizes to provide accurate estimates at the county level. The increasing costs associated with designing and implementing state-wide boater surveys will further limit our ability to conduct sufficiently large scale studies on a timely basis.

In addition to the state-wide boater surveys, other boating studies have concentrated on particular boating issues and topics. Holecek et. al., (1976) and Humphrys (1989 and 1987) have focused on specific water bodies or boating areas. Several studies have concentrated on types of boating activity and particular boater segments such as marina users and transient boaters (Bell and Leeworthy, 1987; Stewart and Stynes, 1990; Talhelm, 1986). Other studies and reports have examined specific issues, such as economic impact (Stynes, 1983), identification of market areas (Peterson, 1991), and carrying capacity (Humphrys, 1990, 1991; Ashton, 1983). These studies contributed to understanding boating use for particular segments of boaters or particular geographical areas, and/or explored specific factors that influence boating use and boating behavior. The results of these studies, limited by their purposes (e.g., economic impact, feasibility assessment) and sample sizes, were insufficient to estimate state-wide boating use. Rarely have the results from these studies been used to develop methods for projecting or estimating boating activities beyond the period of time during which the data were collected.

Boating registrations are a potentially important source of data for estimating and predicting boating use. In Michigan, all motorized boats and non-motorized craft over 16 feet in length must be registered. The Office of the Secretary of State maintains

information on these registered boats (901,480 in 1994) including: length, type of craft (pontoon, canoe), mode of power (e.g., non-motorized, sail, outboard, inboard) and the location of the owners residence. There are some obvious advantages associated with boat registration data: (1) the data are gathered on a continuous basis; (2) important information is collected about boats and boat owners; and (3) since all boat owners must complete a registration form it provides accurate information on the number and type of boats registered in each county.

Registration data however do not provide direct estimates of boating activity or behaviors. First, the registration data only provide information on where the boat owner resides, not where boats are stored during the boating season, or the counties where they are used. A large number of registered boats are not stored or used in the owner's residence county. Second, the data collected on registered boats and boat owners do not provide adequate information to estimate or allocate use to different regions or counties. In addition, current boat registration data include boats which are inactive and boats whose registrations have expired. Direct application of this information (e.g., 901,480 x days of boating) can result in inflated estimates of the number of active recreational boats, boat days, "need " for facilities, and the economic impact of boating.

Current information on boating facilities and services is not available from any single source. Several data sets provide information on the "supply", location and use of some recreational boating related resources and facilities-services. The Michigan Tourism Resource Database includes information related to boating opportunities such as numbers and acres of lakes, number of boating access sites and miles of streams/rivers (Spotts,

1995). The 1994 Great Lakes Marina Inventory identified and collected detailed information from 627 Great Lakes marinas with 10 or more slips/spaces (Talhelm et al. 1995). The data base contains information on number of seasonal rental and transient slips and spaces (e.g., moorings, dry stack), the number of occupied spaces, and marina services. The Michigan Department of Natural Resources maintains information on marinas that require permits, and the number of nights transient slips at publicly operated Great Lakes marinas are rented/occupied. Most of these data are on a county level, and they provide information that is useful in understanding boating use and its spatial patterns. However, these secondary data sets are limited in their scope. For example, the 1994 Great Lakes Marina Inventory only included Great Lakes coastal marinas with 10 or more slips, not all marinas. More importantly, no system or method is available for combining and utilizing different supply data to estimate the amount or distribution of boating activity in different regions or counties.

It is clear that reliable and timely estimates of recreational boating use and locations of use are important to agencies and businesses making decisions about recreational boating facilities. A variety of secondary data sets are available and could be used to estimate boating use and its spatial patterns. Evidence shows a growing need to integrate existing boating information/knowledge in order to develop a system of models than can relate and utilize available data to produce cost-effective and reliable estimates of recreational boating use, and the locations of this use. The information from the 1994 Michigan Boating Survey (Stynes et al., 1995) and previous state-wide and regional

boating studies along with various secondary data provide an excellent basis for developing such a system.

PURPOSE AND OBJECTIVES OF THE STUDY

The primary purpose of this study is to produce reliable county level estimates of boating use by different boat segments. The objective is to generate reliable and cost effective estimates of: (1) number of boats kept in counties during the boating season, (2) number of boats in different types of storage in counties (e.g., marinas, second homes), and (3) boat days in different counties by boat storage segments. There are two main reasons for using type of storage as the basis for the system of models. First, boating use and spatial patterns of use differ between boats in different types of storage. For example, boats stored at coastal marinas are larger and more likely to be used on the Great Lakes. A single model that does not segment by storage type can not satisfactorily model the boating use patterns of different boat storage segments. Segmentation increases the efficiency of modeling. Second, use estimates by storage type better meet the information needs of public and private sector providers. For example, number of boats stored at marinas in a county is much more relevant to the feasibility of a proposed marina than an estimate of all boats stored (or registered) in the county.

A system of models utilizing existing secondary data sources and the recent boater survey is developed to accomplish the study objectives. The system of models:

1. Incorporates boat registration information (length, location of owner's residence) to produce reliable estimates of the number of boats in different types of storage in different counties.
2. Utilizes "model produced" estimates of the number of boats in different types of storage in different counties to estimate the number of boat days in Michigan counties.

THE ORGANIZATION OF THE STUDY

The study is presented in five chapters. The next chapter reviews previous boating studies and literature relating to modeling recreational use and spatial patterns of recreational uses with an emphasis on trip allocation concepts, trip allocation methods, and distance functions. The third chapter describes the data sets used to estimate the models and the overall structure of the system of models. The fourth chapter presents the process of estimating the models, and the results of the models including estimates of boats in different storage segments, number of boats kept in different types of storage in counties and, boat days in counties by boats kept in different types of storage. The fifth and final chapter provides a overview of the model development process, evaluates the performance of the models and offers recommendations for improving the models and information used by the models.

CHAPTER II

LITERATURE REVIEW

The purpose of this chapter is to review literature and studies that (1) have examined boating activities and spatial patterns of recreational boating in Michigan, (2) present concepts and theories of recreational travel, and (3) discuss relevant approaches to/for modeling recreational use. The discussion includes a review of Michigan boating studies and previous attempts to model Michigan boating use. Special emphasis is placed on the 1994 Michigan Boating Survey, the principal data used to develop the models. The chapter also reviews theories and major components of recreational travel that serve as the conceptual basis for boating models. This chapter concludes with a review of use estimation and trip distribution models.

PREVIOUS STUDIES AND MODELING OF RECREATIONAL BOATING IN MICHIGAN

This section reviews studies that provide a description of boating spatial patterns in Michigan over the past three decades, the results of 1994 Michigan Boating Survey with emphasis on current boating use patterns, and a boating use system based on spatial distribution named RECSYS SYMAP.

Spatial Patterns of Recreational Boating in Michigan

Nine major statewide recreational boating surveys have been conducted over the past thirty years (MORD, 1964; Michigan Waterways Division, 1965; Department of Park and Recreation Resource, MSU, 1968; Recreation Resource Consultants, 1971; Recreation Resource Consultants, 1974; Michigan Waterways Division, 1977; Michigan Sea Grant, 1980; Travel, Tourism and Recreation Center, MSU, 1986; Department of Park, Recreation and Tourism Resources, 1994). Those studies sampled boats from the Michigan boating registration lists maintained by the Office of the Michigan Secretary of State. They collected information on: characteristics of fleet (e.g., size, type and age of boats), characteristics of boat owners, boat storage, number and locations of boat launchings, volume and locations of boat use, boating related spending, and special topics/issues (e.g., law enforcement, pump-outs). Information from these studies provides descriptions of boating use characteristics and patterns at the time of the studies.

The findings from three major studies provide a description of the spatial patterns of recreational boating in the years 1965, 1974, and 1986. Some of the relevant findings include:

> The 1965 Boating Survey (Michigan Waterway Division, 1965) sampled 13,670 boats. It found that the boats/boaters in the counties in the southeast of the state have highest level of boating use. On the other hand, the Upper Peninsula, plus six areas along the coastline of Lower Michigan provided the highest level of boating "supply". The lowest "supply" was in the central/south Lower Peninsula. This was one of the first studies that identified the extent of the south-to-north flow of recreational boats. The study found that the majority of boats used in southern Michigan counties were registered in the local area -- these were not destination counties. For example, 98% of boats operated in Wayne county were registered by owners residing in the county. Conversely, only a small portion (8%) of the recreational craft used in Roscommon county were registered by residents of the county, 14% of boats used in Roscommon county were owned by a person residing in Wayne county.

The 1974 studies (Chubb and Chubb, 1975) sampled 13,600 registered boats and showed a similar distribution of boating origins, destination patterns and flows. Boats registered in southern Michigan counties comprised the largest share of recreational boating use. Southern Michigan counties "exported" boat days to northern counties. Boats registered by owners residing in northern counties were generally used in northern Michigan. For example, more than 95% of boat days generated by boats registered in the northern lower peninsula of Michigan and UP were used in the region. Only 68% of boat days by boats registered in southern Michigan counties occurred in the region, 29% of the days occurred in northern Michigan.

The 1986 statewide study (Talhelm et. al., 1988) sampled 10,089 registered boats with findings that were consistent with the previous boating studies. The study showed that more populated southern Michigan counties and counties with more boating opportunities located near population centers experienced the highest amount of recreational boating use. Fifty-eight percent of all recreational boat days occurred in counties comprising the southern half of lower Peninsula, 33% of boat days were in the northern half of lower Michigan, and 9% were in the Upper Peninsula. Counties in southeast, the thumb, and central Lower Peninsula generated and exported more boat days than were "imported" by boaters from outside the regions. All other counties imported more boat days than days by boats registered in the counties.

The findings from these and other previous boating studies provide relevant information on the spatial distribution and patterns of recreational boating use. They reveal that the basic spatial patterns of boating use and flow of recreational boats have been fairly stable over years. The studies showed that: (1) Boats registered in southeastern Michigan counties generate the majority of boat days in the state. (2) Boating opportunities and resources are unevenly distributed across the state. (3) The Upper Peninsula, northern Lower Peninsula, coastal counties and lake areas provided relatively more boating opportunities and as a result attract a greater share of boat days from outside these regions and counties. (4) The majority of boat days in southern Michigan counties are by boats registered in the county or nearby counties. There is relatively little north-to-south recreational boating travel. Very few of the boats that are operated in

southern Michigan are registered in northern counties. (5) A comparatively high percentage of boat days in northern Michigan counties are by boats registered in southern counties.

1994 Michigan Boating Survey

The 1994 Michigan Boating Survey provides the most current information on statewide boating activities. The data collected from boaters are crucial in estimating the models developed in this study. The study provides information on the characteristics of boat owners (Table 1), characteristics of the fleet (Table 2), boating use by storage type (Table 3), and spatial patterns of boating activities (Tables 4 and 5).

Boat owners are considerably older than the rest of the Michigan's population with median age around 56. About half of all boat owning households have one or more children in the family. The median income is just under $40,000 a year which is somewhat higher than the state average. Approximately a third of boat owners own some type of seasonal home or cottage (Table 1).

Most of Michigan's registered recreational watercraft are small boats. Eighty percent are twenty feet or shorter. Over half of the registered boats are powered by outboard motors, a quarter are either inboards or inboard-outboards. Pontoons, canoes, and rowboats comprise 16% of the fleet. Sailboats represent only four percent of the registered fleet.

About sixty percent of registered boats are stored at the owner's permanent residence during the boating season. About a quarter are kept at seasonal homes and about 12 percent at marinas. Over half of the boats are stored on land during the boating

Table1. Boat Owner Characteristics.

	Percentage
AGE OF BOAT OWNER	
younger than 40	21%
41-50	19%
51-60	17%
61-65	11%
66-70	14%
Older than 70	19%
	100%
NO OF ADULTS IN THE HOUSEHOLD	
1	18%
2	70%
3	8%
4	3%
5 or more	1%
	100%
HOUSEHOLD WITH CHILDREN	
no children	53%
1 child	20%
2 children	15%
3 children	8%
more than 4 children	4%
	100%
HOUSEHOLD INCOME	
Under $20,000	22%
$20,000-$39,999	34%
$40,000-$59,999	23%
$60,000-$99,999	16%
Over $100,000	6%
	100%
SEASONAL HOME	
Own a seasonal home in MI	31%
Do not own a seasonal home in MI	69%
	100%

a. Unit of analysis in this table is the boat owner. Sample of boats was weighted inverse to number of boats owned by each respondent.

season, compared to 40 percent in the water or in a dry stack storage space. Just over 40 percent of watercraft are kept at non-waterfront locations during the boating season (Table 2).

Boats stored at permanent homes are transported/trailered greater distances -- approximately 47 miles one way to the locations where they are used than boats kept in other types of storage (Table 3). On average, the marinas where boats are stored during the season are 87 miles from the owner's permanent residence. The distance between the boat owners permanent residence and second homes where they store their boats averages 225 miles.

Michigan registered boats generated an estimated 13.4 million boat days in 1994, 4.8 million on Great Lakes and 8.6 million on inland waters. On average, boats kept at marinas are used more frequently. Over 70% of the days by boats kept at permanent homes or second homes occur on inland lakes or rivers. The two most frequent uses of boats are fishing (56% of use or days) and pleasure cruising (39% of use or days). The type of boating activities differ among boats kept at different types of storage during the boating season. Seventy percent of the use of boats kept at permanent residences is for fishing. In contrast, 70 percent of the use for boats kept at the marinas involves pleasure cruising (Table 3).

The study estimated that about 2.5 million boat launchings take place on inland waters each year and 1.4 million launchings occur on Great Lakes waters. Boats kept at permanent residences account for over eighty percent of Great Lakes launchings and about 90 percent of launchings on inland lakes and streams. Seven percent of the

Table 2. Characteristics of Watercraft.

	Percent
BOAT SIZE	
<16'	52%
16'-20'	28%
21'-28'	16%
>29'	4%
	100%
BOAT TYPE	
Inboard	19%
Inboard/outboard	6%
Outboard	56%
Sail, unpowered	1%
Sail, with power	3%
Pontoon	8%
Canoe or Row	8%
Personal watercraft	0%
Other	0%
	100%
STORAGE FACILITY	
Permanent residence	59%
Cottage or second home	25%
Public marina	3%
Rented space in commercial marina	6%
Owned space in marina/dockaminium	1%
Yacht/boat club	2%
Other	4%
	100%
STORAGE LOCATION	
On land	55%
In a dry stack facility	1%
In the water (wet slip, mooring or dockside)	39%
Attached to or on a larger boat	1%
Other	4%
	100%
TYPE OF STORAGE LOCATION	
A waterfront site w/ access to the Great Lakes	24%
An inland lake waterfront site	33%
A river or stream waterfront	3%
A non-waterfront site	41%
	100%

Table 3. Summary by Boat Storage Categories.

	Permanent Residence (n=327,561)	Second Home (n=138,797)	Marina (n=66,622)	All Boats[a] (n=555,188)
DISTANCE TRAVELED[b] (avg. miles)				
From residence location to storage locations	NA	225.33	86.85	82.56
From storage location to boating destinations	47.15	22.54	32.64	38.20
AVERAGE BOATING DAYS OF USE				
Total Boat Days	22.2	25.0	31.3	24.2
Great Lakes Boat Days	6.6	5.5	24.4	8.7
Inland Boat Days	15.6	19.4	6.9	15.4
TYPES OF BOATING				
Pleasure Boating	29%	48%	73%	39%
Fishing	66%	45%	23%	56%
Waterskiing	3%	4%	2%	3%
Other	1%	2%	2%	2%
TIMES TRANSPORTED & LAUNCHED AT				
Great Lakes Sites	3.7	0.6	1.2	2.6
Inland Sites	6.8	1.3	0.4	4.5
TEMPORARY USE OF MARINA SPACE (pct)	6%	2%	26%	7%
ANNUAL OPERATING EXPENSES				
Boating Equipment	$133	$148	$419	$182
Repair & Maintenance	$129	$138	$515	$183
Seasonal Slip Rental or Dry Stack	$11	$28	$799	$115
Put in and Haul Out fees	$16	$18	$75	$26
Off-Season Storage	$23	$47	$330	$68
Fuel	$76	$70	$288	$101
Boat Insurance	$47	$64	$253	$79
Total	$431	$525	$2,730	$753
AGE OF BOAT OWNER (Years)	54	59	53	55
HOUSEHOLD INCOME DISTRIBUTION				
Under $20,000	20%	16%	7%	18%
$20,000-$39,999	32%	25%	23%	29%
$40,000-$59,999	21%	16%	23%	20%
$60,000-$99,999	13%	20%	21%	16%
Over $100,000	4%	11%	14%	7%
OWN A SEASONAL HOME IN MICHIGAN	14%	89%	22%	34%

a. All boats include boats stored at permanent homes, second homes, marinas and other storage facilities.
b. The distance traveled within county is assigned as 20 miles. The distance is one way distance.

registered boats that were used in 1994 rented a marina slip (at least once) on a temporary/transient basis. Over one fourth of boats kept at marinas rented a transient slip/space at another marina at least one night during the boating season (Table 3).

In 1994, Michigan boat owners spent $418 million on equipment, repairs, slip rental, insurance, storage and fuel. Owners of boats kept at marinas spend an average of six times more annually than the owners of boats stored at permanent residences, and five times more than is spent on boats kept at second homes (Table 3).

Over sixty percent of the owners of registered boats live in the southeast and south inland regions, but only 49% of boats are stored in these two regions. On the other hand, about 8% of Michigan boat owners reside in the northeast and northwest regions, but more than 15% of registered boats are stored in these two regions during the boating season. Over 90% of boat owners that live in northern Michigan (including northeast, northwest, north-inland, southern U.P. and northern U.P. regions) keep their boats within these regions during the season. In contrast, only 70% - 75% of the boat owners from southeast and south inland regions keep their boats within these regions (Table 4). The 1994 results indicate that the majority of boats are owned by persons living in southern Michigan, and the traditional "south-to-north" boating travel patterns are applicable to 1994 Michigan boating activities.

Boats stored in southeast and inland south regions generate about half of Michigan boat days, and these two regions receive 45% of boat days. Northeast and northwest regions received about 17% of total boat days, and boats stored in these two regions generate about 15% of total boat days in Michigan. Over 98% of boat days

Table 4. Number of Boats in Residence Regions and Storage Regions.

No. of boats'	REGIONS OF RESIDENCE												
STORAGE REGIONS	South-East	Central-East	North-East	North-West	Central-West	South-West	South Inland	North Inland	U.P. South	U.P. North	Out of State	Total	(pct.)
South East	73,928	13	259	0	0	68	12,519	155	0	0	1,193	88,136	16.3%
Row pct.	*83.9%*	*0.0%*	*0.3%*	*0.0%*	*0.0%*	*0.1%*	*14.2%*	*0.2%*	*0.0%*	*0.0%*	*1.4%*		
Column pct.	*75.4%*	*0.0%*	*1.7%*	*0.0%*	*0.0%*	*0.3%*	*5.3%*	*0.4%*	*0.0%*	*0.0%*	*4.2%*		
Central East	1,387	20,181	13	0	0	0	4,720	273	0	0	95	26,669	4.9%
Row pct.	*5.2%*	*75.7%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*17.7%*	*1.0%*	*0.0%*	*0.0%*	*0.4%*		
Column pct.	*1.4%*	*75.6%*	*0.1%*	*0.0%*	*0.0%*	*0.0%*	*2.0%*	*0.7%*	*0.0%*	*0.0%*	*0.3%*		
North East	5,975	2,298	14,742	179	0	0	6,187	790	0	29	2,192	32,392	6.0%
Row pct.	*18.4%*	*7.1%*	*45.5%*	*0.6%*	*0.0%*	*0.0%*	*19.1%*	*2.4%*	*0.0%*	*0.1%*	*6.8%*		
Column pct.	*6.1%*	*8.6%*	*95.1%*	*0.6%*	*0.0%*	*0.0%*	*2.6%*	*2.1%*	*0.0%*	*0.2%*	*7.7%*		
North West	3,264	0	84	27,817	192	1,581	10,825	703	0	10	7,620	52,095	9.6%
Row pct.	*6.3%*	*0.0%*	*0.2%*	*53.4%*	*0.4%*	*3.0%*	*20.8%*	*1.3%*	*0.0%*	*0.0%*	*14.6%*		
Column pct.	*3.3%*	*0.0%*	*0.5%*	*97.5%*	*0.8%*	*6.8%*	*4.6%*	*1.9%*	*0.0%*	*0.1%*	*26.6%*		
Central West	727	0	0	10	21,380	1,367	2,731	108	0	40	816	27,178	5.0%
Row pct.	*2.7%*	*0.0%*	*0.0%*	*0.0%*	*78.7%*	*5.0%*	*10.0%*	*0.4%*	*0.0%*	*0.1%*	*3.0%*		
Column pct.	*0.7%*	*0.0%*	*0.0%*	*0.0%*	*93.6%*	*5.9%*	*1.2%*	*0.3%*	*0.0%*	*0.3%*	*2.9%*		
South West	0	0	0	0	13	18,438	2,379	0	0	0	1,906	22,736	4.2%
Row pct.	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*81.1%*	*10.5%*	*0.0%*	*0.0%*	*0.0%*	*8.4%*		
Column pct.	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*79.7%*	*1.0%*	*0.0%*	*0.0%*	*0.0%*	*6.7%*		
South Inland	5,734	213	0	324	0	1,565	166,855	0	0	0	4,819	179,510	33.1%
Row pct.	*3.2%*	*0.1%*	*0.0%*	*0.2%*	*0.0%*	*0.9%*	*93.0%*	*0.0%*	*0.0%*	*0.0%*	*2.7%*		
Column pct.	*5.8%*	*0.8%*	*0.0%*	*1.1%*	*0.0%*	*6.8%*	*71.0%*	*0.0%*	*0.0%*	*0.0%*	*16.9%*		
North Inland	4,833	2,933	0	0	1,146	127	23,162	33,274	0	0	4,051	69,527	12.8%
Row pct.	*7.0%*	*4.2%*	*0.0%*	*0.0%*	*1.6%*	*0.2%*	*33.3%*	*47.9%*	*0.0%*	*0.0%*	*5.8%*		
Column pct.	*4.9%*	*11.0%*	*0.0%*	*0.0%*	*5.0%*	*0.5%*	*9.8%*	*89.7%*	*0.0%*	*0.0%*	*14.2%*		
U.P. South	2,124	1,042	81	0	108	0	2,855	478	12,332	171	4,251	23,440	4.3%
Row pct.	*9.1%*	*4.4%*	*0.3%*	*0.0%*	*0.5%*	*0.0%*	*12.2%*	*2.0%*	*52.6%*	*0.7%*	*18.1%*		
Column pct.	*2.2%*	*3.9%*	*0.5%*	*0.0%*	*0.5%*	*0.0%*	*1.2%*	*1.3%*	*93.7%*	*1.3%*	*14.9%*		
U.P. North	0	0	321	210	0	0	2,627	1,300	819	13,061	1,380	19,717	3.6%
Row pct.	*0.0%*	*0.0%*	*1.6%*	*1.1%*	*0.0%*	*0.0%*	*13.3%*	*6.6%*	*4.2%*	*66.2%*	*7.0%*		
Column pct.	*0.0%*	*0.0%*	*2.1%*	*0.7%*	*0.0%*	*0.0%*	*1.1%*	*3.5%*	*6.2%*	*98.1%*	*4.8%*		
Out of State	68	0	0	0	0	0	311	0	15	6	272	671	0.1%
Row pct.	*10.1%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*46.3%*	*0.0%*	*2.2%*	*0.9%*	*40.5%*		
Column pct.	*0.1%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*0.0%*	*0.1%*	*0.0%*	*1.0%*		
Total	98,040	26,680	15,501	28,539	22,838	23,145	235,171	37,080	13,166	13,316	28,595	542,071	
(percent)	*18.1%*	*4.9%*	*2.9%*	*5.3%*	*4.2%*	*4.3%*	*43.4%*	*6.8%*	*2.4%*	*2.5%*	*5.3%*		

note: Cases failed to report storage location or residence location are excluded from analysis

generated by boats stored in northern Michigan (including northeast, northwest and U.P. regions) are from within the region. In comparison, only 80% to 90% of boat days generated by southern Michigan boat owners (including southeast, southwest, south inland, central west and central east regions) are captured within the regions (Table 5). Southern Michigan continues to generate and accommodate the greatest number of boat days.

There is a very evident south-to-north pattern from locations where boat owners reside to locations where boats are stored during the season. More boats owned by persons residing in the southern part of the state are stored in other regions. A high percentage of theses boats are stored in northern counties. The south-to-north pattern exists, but is less prominent for movement of boats from where they are stored to where they are used.

An Early Attempt to Model Spatial Patterns of Recreational Boating in Michigan

Although the previous studies provide information on the pattern of recreational boating use in Michigan, there has been only one major attempt to model spatial patterns. The RECSYS (Michigan Recreation System) was one of the earliest attempts to model recreational travel flows for use in planning purposes. RECSYS was developed as part of an effort "to provide a balanced and orderly approach to the problems of meeting current and future recreation needs, and to assure that maximum benefits are obtained from state, county, municipal, and private investment in outdoor recreation land and development" (Michigan Department of Conservation, 1966). It was proposed as a method for quantifying recreation "needs" on a county-by-county basis. It was intended to provide

Table 5. Number of Boat Days in Storage Regions and Destination Regions.

Boat Days* 000' Destination Regions	REGIONS OF STORAGE											
	South-East	Central-East	North-East	North-West	Central-West	South-West	South Inland	North Inland	U P South	U P North	Total	*(pct.)*
South East	2,004.4	1.1	4.1	0.2	0.4	1.7	69.7	2.2	0.1	0.0	2,084.0	*17.0%*
Row pct.	*96.1%*	*0.1%*	*0.2%*	*0.0%*	*0.0%*	*0.1%*	*3.3%*	*0.1%*	*0.0%*	*0.0%*		
Column pct.	*90.5%*	*0.3%*	*0.6%*	*0.0%*	*0.1%*	*0.3%*	*1.8%*	*0.1%*	*0.0%*	*0.0%*		
Central East	17.8	353.0	1.6	1.8	0.0	0.5	69.3	1.3	0.5	0.0	445.7	*3.6%*
Row pct.	*4.0%*	*79.2%*	*0.4%*	*0.4%*	*0.0%*	*0.1%*	*15.5%*	*0.3%*	*0.1%*	*0.0%*		
Column pct.	*0.8%*	*82.1%*	*0.2%*	*0.1%*	*0.0%*	*0.1%*	*1.8%*	*0.1%*	*0.1%*	*0.0%*		
North East	10.6	28.5	635.9	3.4	1.4	0.2	47.8	14.0	0.2	0.1	742.1	*6.0%*
Row pct.	*1.4%*	*3.8%*	*85.7%*	*0.5%*	*0.2%*	*0.0%*	*6.4%*	*1.9%*	*0.0%*	*0.0%*		
Column pct.	*0.5%*	*6.6%*	*97.8%*	*0.3%*	*0.3%*	*0.0%*	*1.2%*	*0.8%*	*0.0%*	*0.0%*		
North West	19.5	2.8	2.8	1,206.5	7.4	19.5	73.1	28.7	0.3	0.0	1,360.6	*11.1%*
Row pct.	*1.4%*	*0.2%*	*0.2%*	*88.7%*	*0.5%*	*1.4%*	*5.4%*	*2.1%*	*0.0%*	*0.0%*		
Column pct.	*0.9%*	*0.7%*	*0.4%*	*98.3%*	*1.4%*	*3.4%*	*1.9%*	*1.7%*	*0.0%*	*0.0%*		
Central West	1.5	0.1	0.6	0.4	456.8	17.3	46.2	1.3	0.0	0.3	524.3	*4.3%*
Row pct.	*0.3%*	*0.0%*	*0.1%*	*0.1%*	*87.1%*	*3.3%*	*8.8%*	*0.2%*	*0.0%*	*0.1%*		
Column pct.	*0.1%*	*0.0%*	*0.1%*	*0.0%*	*84.4%*	*3.0%*	*1.2%*	*0.1%*	*0.0%*	*0.1%*		
South West	2.0	0.0	0.0	1.1	24.2	486.9	57.5	0.0	0.0	0.0	571.7	*4.7%*
Row pct.	*0.3%*	*0.0%*	*0.0%*	*0.2%*	*4.2%*	*85.1%*	*10.1%*	*0.0%*	*0.0%*	*0.0%*		
Column pct.	*0.1%*	*0.0%*	*0.0%*	*0.1%*	*4.5%*	*85.2%*	*1.5%*	*0.0%*	*0.0%*	*0.0%*		
South Inland	90.0	14.3	0.4	3.0	21.2	37.4	3,337.2	9.5	0.0	0.0	3,513.1	*28.6%*
Row pct.	*2.6%*	*0.4%*	*0.0%*	*0.1%*	*0.6%*	*1.1%*	*95.0%*	*0.3%*	*0.0%*	*0.0%*		
Column pct.	*4.1%*	*3.3%*	*0.1%*	*0.2%*	*3.9%*	*6.5%*	*85.6%*	*0.6%*	*0.0%*	*0.0%*		
North Inland	35.5	25.5	0.3	2.8	6.5	0.0	151.9	1,556.0	0.0	0.1	1,778.7	*14.5%*
Row pct.	*2.0%*	*1.4%*	*0.0%*	*0.2%*	*0.4%*	*0.0%*	*8.5%*	*87.4%*	*0.0%*	*0.0%*		
Column pct.	*1.6%*	*5.9%*	*0.0%*	*0.2%*	*1.2%*	*0.0%*	*3.9%*	*94.0%*	*0.0%*	*0.0%*		
U P South	4.7	1.0	3.2	5.6	6.7	0.5	11.8	6.2	654.2	1.6	695.5	*5.7%*
Row pct.	*0.7%*	*0.1%*	*0.5%*	*0.8%*	*1.0%*	*0.1%*	*1.7%*	*0.9%*	*93.8%*	*0.2%*		
Column pct.	*0.2%*	*0.2%*	*0.5%*	*0.5%*	*1.2%*	*0.1%*	*0.3%*	*0.4%*	*98.1%*	*0.4%*		
U P North	28.5	3.6	1.4	2.7	16.6	7.5	35.1	35.7	11.7	430.8	573.7	*4.7%*
Row pct.	*5.0%*	*0.6%*	*0.2%*	*0.5%*	*2.9%*	*1.3%*	*6.1%*	*6.2%*	*2.0%*	*75.0%*		
Column pct.	*1.3%*	*0.8%*	*0.2%*	*0.2%*	*3.1%*	*1.3%*	*0.9%*	*2.2%*	*1.8%*	*99.5%*		
Total	2,214.5	430.1	650.3	1,227.5	541.2	571.6	3,899.5	1,654.8	667.0	432.8	12,289.4	
(percent)	*18.0%*	*3.5%*	*5.3%*	*10.0%*	*4.4%*	*4.6%*	*31.7%*	*13.5%*	*5.4%*	*3.5%*		

a Cases failed to report the location of boating destination, storage location and types of boat storage are excluded from analysis
Few respondents indicate they used or stored their boats out of the state are also excluded

predicted "demand" and relate it to "supply capacity" (Michigan Department of Conservation, 1966).

RECSYS is based on the spatial distribution of the location where boating activities take place (destinations), the area distribution of potential population sources (origin) and the location of the highways connecting origins and destinations (Chubb, 1967). It predicts the spatial distribution of recreation demand by simulating the movement of recreation users from origin areas to destinations over the highway travel network. This simulation model is based on linear systems theory. RECSYS system assumes that recreational trips to a destination from any origin is some function of a time-distance factor and the drawing power or attractiveness at the destination.

The RECSYS system developed by Ellis (1964) included three major components:

1. Origin component (O),

   O (boat days generated by each origin) = a determinable quantity.

2. Transportation link component (H),

   H (for any highway link)= $1/R*P_h$

   Where R is a resistance factor, and $R=k_1*(T)+k_2*(C)^{\beta}$.
   - T = time in hours estimated to travel along the link, and T= distance/speed.
   - C = the direct cost of traveling along the link.
   - k_*= constant.
   - β = exponent.

   Where P_h is the demand pressure along the link.

3. Destination component (D),

   D (into the destination) = $A*P_d$.

   Where A is the attractiveness of the destination.

   Where P_d is the demand pressure into the destination area.

Once all the components were identified and quantified, linear graphs[2] were developed to build and solve the appropriate model for the recreation activity under a specified actual structure of the recreation system[3].

Chubb (1967) utilized RECSYS and boating use data from a 1965 survey of recreational boat owners to predict use at various destinations. "First run" predictions of the model were very different from actual use estimated by the survey. After calibration runs, the RECSYS simulation for 1965 recreational boating use retained a 19.2 percent standard deviation. For 43% of destination counties, predicted use was within five percent of survey estimated use[4]. For 28% of destination counties, predictions of use varied 5-10% from survey estimated use. The largest discrepancy was -82.6% for Emmet county.

Chubb identified three major problems or disadvantages with RECSYS as a method for simulating recreational boating use patterns. First, the technique requires a large amount of data on both boating "supply" and "demand". This information is normally obtained through large scale surveys. Design and testing of RECSYS also requires highly specialized personnel. Finally, (at the time) RECSYS required sophisticated computer facilities.

In addition, RECSYS only estimates number of boat days in a destination, not types or amounts of different boating uses. Type of and distribution of boat uses are crucial to planning access and facilities, and managing recreational boating. For example

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[2] Linear graphs derive from the mathematical discipline of topology.

[3] The structure of a recreation system is based on the spatial arrangement of cities, counties and highways. It does not vary across recreation activities.

[4] Because Chubb's report did not provide sampling errors for survey estimates, it is difficult to determine the accuracy of survey based estimates.

estimates of only total number of boat days do not provide adequate information (e.g., use by different size of boats) to estimate "needs" for launching facilities. RECSYS also failed to incorporate information on where the boat was stored or types of storage (marina, second home). The RECSYS system estimates number of boat days generated in the counties where registered boat owners lives, not necessarily where the boats are kept during the season. Studies in 1986 and 1994 clearly show that where boats are kept during the season, and type of storage are important in estimating and distributing boating use.

Conclusions from Previous Studies And RECSYS System

The RECSYS system and previous studies of recreation boating activity and spatial patterns provide findings and conclusions that can improve the reliability and efficiency of recreational boating models. First, boats kept in different types of storage have distinct boating use patterns. Thus, storage type should be incorporated as an important element in boating models. Second, efforts to model (estimate) boating related travel and transportation of boats from the owner's residence (origin) to boating destinations can be improved though a two-step process which first allocates boats to storage locations, and from there to use (destination) locations. Third, the long established, and often verified "south-to-north" patterns of recreational boating and transportation of boats should be incorporated into boating use models. Fourth, the assumption of distance decay holds well in the RECSYS system. Distance is a key factor in distributing boat days from origins to various (use) destinations. Finally, it is financially unrealistic to assume that we will be able to regularly conduct large-scale

surveys to provide data to estimate boating use at the local (county) level. It is necessary to develop models that can utilize secondary data that are collected on a regular basis.

RECREATIONAL TRAVEL

This section of the literature review will focus on conceptual models of recreation and tourist travel, and factors that have been identified as influencing the spatial movement of recreational travel. The purpose is to provide a theoretical basis for the variables that are considered for inclusion of the model developed in this study.

Lowe and Moryadas (1975) present a conceptual framework of the causes of spatial movement. The four major factors in their framework are: place and time utility, complementarity, intervening opportunities, and transferability. Although the framework proposed by Lowe and Moryadas is helpful in understanding reasons of movement, travel is far more complex than distribution of products. Socioeconomic differences, cultural variations, differences in attitudes and perceptions, interpersonal communication, contextual differences, different decision-making rules (i.e., habitual vs. benefit maximizing decisions), variation in purpose/motivation, and level of involvement all influence travel decisions (Murdie, 1965; Wolpert, 1965; Tiedemann and Milstein, 1966; Ray, 1967; Marble and Bowlby, 1968; Sea, 1969; Golledge, 1969, 1979; Mayo, 1973; Hunt, 1975; Kelly, 1980; Smith, 1985; Fesenmaier, 1990; Um and Crompton, 1990; Johnson and Messmer, 1991; Dadgoster and Isotalo, 1992).

Since the late 1960s, researchers have attempted to formulate models dealing with various aspects of the spatial structure of recreational travel. Although emphasis is

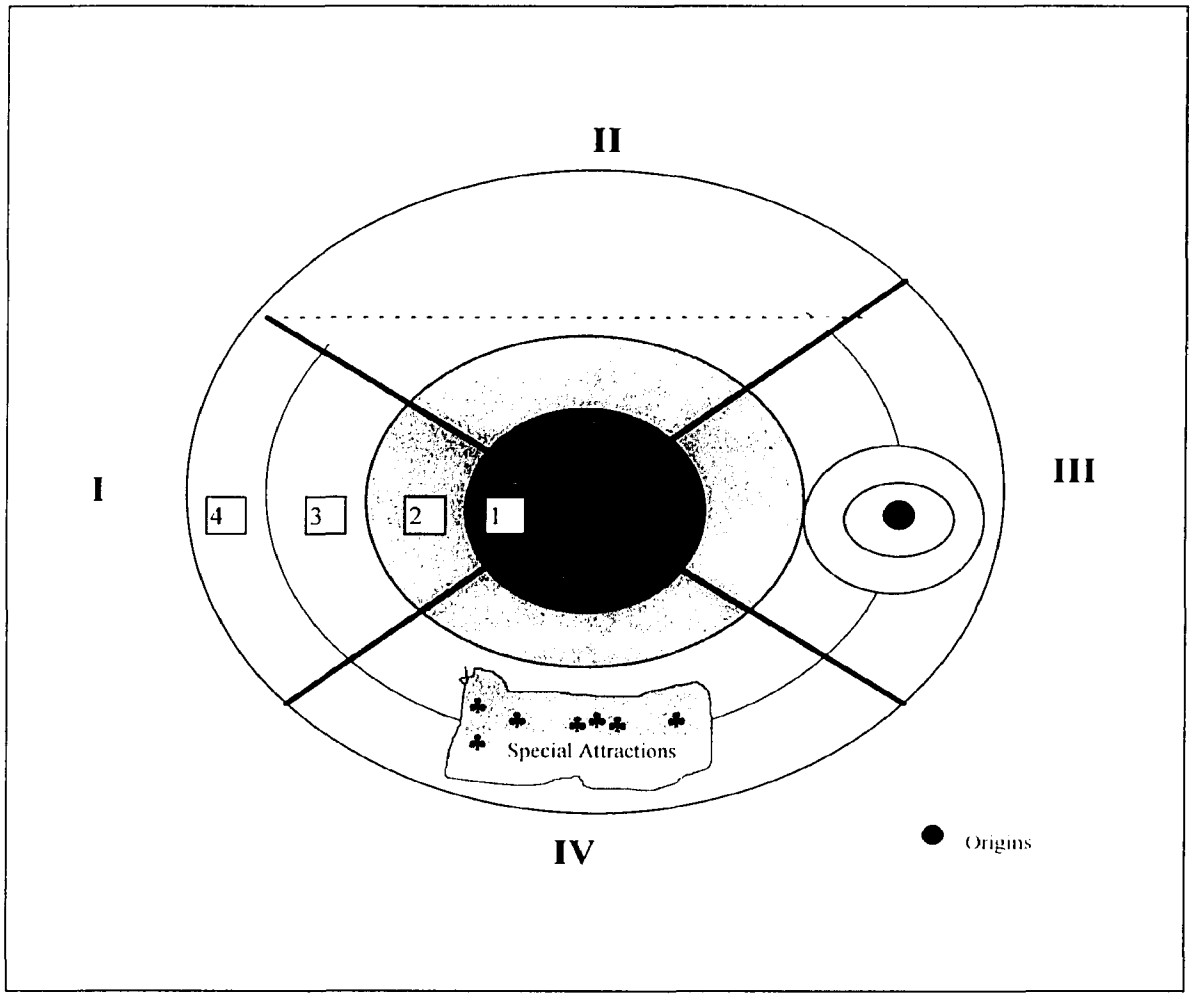
placed on different components of the system, the basis of most models is an origin-linkage-destination system.

Mariot (cited in Matley, 1976) proposed three different routes which may link a place of permanent residence (origin) to a tourist center (destination) - an access route, a return route, and a recreational route. Campbell (1966) proposed a " recreational and vacational travel model" of different patterns of movement away from an urban center. Campbell distinguished between various traveler groups based on the relative importance assigned the travel component (vacationist) and stay component (recreationist) of their trips. Lundgren (1982) formulated a model focusing on the spatial hierarchy of tourism flows. Destinations with different degrees of mutual travel attractions were modeled and tourist flows were classified based on four different types of destinations: metropolitan destinations, peripheral urban destinations, peripheral rural destinations, natural environment destinations.

Several researchers have concentrated on factors that impact the volume of tourist travel (Mercer, 1970; Rajotte, 1975; Ruppert, 1978; Greer and Wall, 1979). Their research indicates that the volume of visits from origins to different destinations decreases as the travel costs (time, money and effort) increases. Their work also indicates that domestic travel is typically seen in terms of concentric zones surrounding an origin (city) defined on the basis of blocks of available leisure time: a day-trip zone, a weekend zone, and a holiday or vacation zone.

Yokeno (1974) and Moissec (1976 and 1977) concentrated on incorporating modifications to hypothesized concentric zones. Moissec's model (Figure 1) presents

Figure 1. Miossec's Model of Tourist Space



different travel zone configurations as effected by different factors and features. In Section I. the origin is surrounded by four concentric time zones. Volume of visits to the outer zones is less because travel cost is higher. However, in the real world, these theoretical "regular concentric zones" are subject to different types of modification. In Section II. the zones are extended and compressed reflecting positive or negative factors, such as climate, political boundary, or historic links. Sector III of the model shows that in reality a series of (origin) cores exist giving rise to concurrent spatial demands. Sector IV incorporates the impact of the "attractiveness" of destinations. The number of visitations to the destination generally declines with distance, but the concentration of visitation may change due to perception of the destination's supply (opportunity) factors.

Key Travel And Trip Distribution Elements

Three key elements or constructs - distance, destination characteristics, and origin (population) characteristics - are important in modeling and understanding recreational travel and trip distribution. A number of authors and research studies have examined the measurement and impact of these elements on the spatial patterns of recreational travel.

Distance

Research has shown repeatedly that distance is one of the most significant predictor variables for forecasting travel patterns between regions. Distance usually represents a major constraint on travel behavior. In most recreational travel studies, the general pattern is for the intensity of travel flows (number of visitations) to decline with greater distances between the origin and destination. This is the well-known distance

decay function[5]. The influences of distance on recreational travel vary. In reviewing many research projects, Smith (1984) found distance explained 30% to 95% variances in predicting number of trips from origins to destinations.

Previous recreational travel studies, have utilized four measures of distance. "Physical distance" is the spatial interval between two points. In most zone to zone recreational travel studies, distance is the spatial interval between population centers and alternative destinations (Cheung, 1972; Freund and Wilson, 1974; Durden and Silberman, 1975; Kim, 1988). "Amount of travel time", such as hours of driving time, is often used as a measure of distance effect (Ellis, 1966; Lentnek, Van Doren and Trail, 1969; Flegg, 1975; Saunders, Senter and Jarvis, 1981). Economic cost of travel (cost per mile) is also used as a method to measure influences of distance. "Economic distance" represents a budgetary constrain to the amount and location of travel/trips (Ellis, 1966; Durden and Silberman, 1975; Witt and Witt, 1990; Morley, 1994). "Perceptual distance" has been proposed by a number of different authors (Cadwallader, 1981; Walmsley & Jenkins, 1992). Perceptual distance is measured based on people's subjective perception of travel distance. Researchers argue that people make travel decisions based on their perceptions of distance, not actual (physical, time, or economic) distance.

Destination Characteristics

The number and quality of attractions available at a destination is a major factor influencing travel decisions (McIntosh and Goeldner, 1990). It is assumed that individuals will allocate their recreation travel in a manner that is consistent with the

[5] The distance decay function in previous studies has been specified in many different mathematical forms, such as Pareto function ($Y=\alpha*D^{-\beta}$), exponential function ($Y=\alpha*e^{-\beta D}$), Pareto-exponential function ($Y=\alpha*d^{-\beta}*e^{-\gamma D}$) (Morrill and Pitt, 1967).

perceived utility associated with alternative recreation destinations (Luce, 1959). However, previous recreational travel studies have not been able to document conclusively the effect of destination attractions on trip decisions and behavior. For example, in 1974 Freund and Wilson's study of Texas statewide recreational travel, the coefficients for attributes of attraction measures ranged from 4.2 to -3.44. The negative sign of attributes of destination attractiveness raised interpretation difficulty because it does not confirm the destination choice theory. However, the negative sign of destination attractions may be explained by multicollinearity in the data set used in the Texas study. The other reason might be that attributes of the destination choice are not directly relevant to the particular recreation activity under study.

The attractiveness or "drawing capacity" of a destination "pulls in" visitors (Hu and Ritchie, 1993). Attractiveness may include attributes, such as natural resources, accessibility, facilities, programs, maintenance, and social use (Louviere and Timmermans, 1992). The problem is that there is no universal measurement of attractiveness. In some recreational travel studies, attractiveness of destinations has been empirically determined, estimated as a parameter in the model (Cesario, 1974, 1975; Baxter and Ewing, 1979; Baxter, 1981; Ewing, 1983). Other studies (Wennergren and Nielson, 1970) have utilized a single supply variable as a measure of attractiveness. Some researchers have utilized a combination of supply variables to formulate an attractiveness index (Cheung, 1972; Freund and Wilson, 1974; Gearing, Swart and Var, 1974; Bell, 1977; Sluyter, 1977; Smith, 1985; Goodrich, 1978; Kim, 1988). Complicated statistical methods, such as factor analysis, have been employed to develop destination

attraction constructs that were then incorporated into recreational travel model (Van Doren, 1967; Lin, Perterson and Rogerson, 1988; Lovingood and Mitchell, 1989; Haider and Ewing, 1990; Dadgostar and Isotalo, 1992; Hsieh, O'Leary, Louviere and Timmermans, 1992; Morrison and Chang, 1993; Klenosky, Gengler and Mulvey, 1993).

Not only is the quality and quantity of attractions important, but also the spatial structure of destination attractions. Both competition and agglomeration effects have been recognized in previous studies (Kim, 1988; Kim and Fesenmaier, 1990; Hanson, 1980; Fotheringham, 1985). Destination competition is a function of the number of attractions within a certain distance that compete for visits from a certain origin. The agglomeration effect occurs when the "collective attraction" of nearby destinations draw more visits to individual destinations than otherwise would occur.

Origin Characteristics

Origin characteristics influence the amount of recreation consumption (demand) from that origin. Characteristics of the origin's population as well as local recreation opportunities are important factors influencing variation in the spatial interactions from an origin area. Many factors influence recreational travel propensities of origin populations: socio-economic attributes such as income, family size, occupation, age, race, family life cycle, marital status, education, culture, gender (Fesenmaier, 1985; Fiske, 1974; Chubb, 1968; Dadgistar and Isotalo, 1992; Jackson, 1980; Ansari, 1971; Kelly, 1980; Witt and Witt, 1990; Morley, 1994); trip purpose/use situation (Lentnek, Van Doren and Trail, 1969; Jaakson, 1988; Perdue and Gustke, 1985; Fesenmaier, 1985; Station and Bonner, 1980; June and Smith, 1987; Ratneshwar and Schocker, 1991),

attitude (Um and Crompton, 1990; Thompson and Cooper, 1979; Debbage, 1991), and level of involvement (Kelly, 1980; Loomis and Ditton, 1993). Megnack (1971), Chubb (1968) and Donnlly, Vaske and Graefe, 1986) examined the relationships between fleet characteristics and travel/transportation patterns and found that boat size, boat type, and type of storage influenced these patterns. The size of an origin population or the combination of population size and socio-economic attributes, are often incorporated as part of gravity type recreational travel models.

APPROACHES OF ESTIMATING RECREATIONAL "DEMAND"

The Bureau of Outdoor Recreation (1975) identified three different levels of demand important in planning and managing outdoor recreation: the "demand" for recreation in the context of broad social and economic policy; the "demand" for site specific recreation, and the "demand" for alternative types of recreation. Four primary approaches are used to estimate the "demand" (use) for outdoor recreation: (1) application of standards, (2) projections of use, (3) structural models of demand and supply, and (4) expression of perceived wants (Bureau of Outdoor Recreation, 1975).

The application of population-based standards is the most popular technique used by park, recreation and planning agencies for estimating the "demand" (and "need") for recreation resources and facilities. Although straight forward, and easy to understand and apply, standards ignore many crucial factors affecting the demand (use) for recreation opportunities such as the individual differences which may affect individual's recreation

participation, different types of users, and the spatial characteristics of recreation "supply" and "demand.".

The projection of use technique estimates demand (use) by extrapolating from use counts, such as visitor days, recreation occasions, permits/registrations or some other measures of participation. The method assumes that all factors affecting the recreation decisions of individuals change at the same rate as the population (or whatever variable is used), and that the supply of recreation opportunities changes at the same rate.

Structural models of demand and supply require specification of the variables assumed to be associated with the "demand" for and "supply" of outdoor recreation. There are limitations associated with this approach. One is that the assumption of causal relationship between recreation participation and the independent variables may be artificial. Unobserved variables, highly correlated independent variables, lack of strong variation in the independent variables may also bias the estimates produced by structural models.

Expression of perceived wants elicited direct expressions of recreational use collected through surveys is another "demand" estimation method. Surveys are used to collect data on recreation participation, preferences, and factors that may affect recreation participation (e.g., income, equipment ownership). Several problems associated with using surveys to directly estimate amounts of recreation participation are present. First, respondents may incorrectly state their recreation (activity) preferences. Second, there may be discrepancies between what people say they do and what they actually do, not due to deliberate falsification, but to inaccurate perceptions. Finally and most importantly,

sampling errors occur due to insufficient sample size, incomplete and unrepresentative sampling frame, inadequate sample selection procedures, and non-response biases. The sampling errors, especially those associated with insufficient sample size, become more obvious and problematic when survey data are used to directly estimate recreational use by different segments of the population and/or recreational use at the local level, or for individual sites. This is a problem associated with statewide boater surveys conducted in Michigan over the last 30 years.

RECREATIONAL TRAVEL MODELS

Many empirical studies have attempted to model recreational travel. The most common models are destination choice models, classification models, trip generation models, and trip distribution models.

Destination choice models predict individual choices of destinations and/or estimate the total number of visits to a particular destination. Most destination choice models are developed at the disaggregate level (i.e., data about individuals or households). Regression and discrete choice models are the most common approaches for modeling (individual) destination choices[6]. Some consider these methods to have a broader range of explanatory variables, and as a result produce more reliable estimates for individual travel behavior especially when the role of individual decision making is apparently crucial (Spear, 1975; Ben-Akiva and Lerman, 1985). Individual recreational

[6] Discrete choice probability models include the binary choice model and the multinominal choice model. The model is developed based on the concept of random utility theory.

travel behavior is best analyzed by studying individuals and utilizing behavior/psychology theories.

Discrete choice models have been successfully used to model recreation and tourism travel modes and destination choices (Burdy, 1971; Flegg, 1976; Sluyter, 1977; Lin, Peterson and Rogerson, 1988; Louviere and Timmermans, 1990; Hsieh, O'Leary, Morrison and Chang, 1993; Morley, 1994). However, there are problems associated with choice models in situations where a large number of choice (destination) alternatives are present (Lerman and Adler, 1975). Large numbers of alternative choices/destinations make theoretically desirable models, such as multinominal models, computationally intractable. Another problem is that general tourism and recreation survey data frequently lack sufficient information on the attributes of alternative destinations as perceived by choice makers (Oum and Lemire, 1991)[7].

Classification models categorize populations into subgroups, based on distinct characteristics, preferences or behavior patterns. When modeling recreational use, distinct models must be developed for different types of users when large variances are present among groups of users. Cluster analysis and discriminant analysis are the most common methods for classification. Cluster analysis is a multivariate technique used to group individuals or objects into groups by minimizing the intra-group variance while

[7] If survey data do not contain the choice maker's subjective evaluation of the attributes of alternative destinations, in order to estimate the standard multinominal choice model, one can only include objectively measured values of the attributes of a destination. Several problems are associated with this issue. First, the objectively measured attributes are not proper variables to use for describing one's destination choice. Second, the use of objectively measured attributes suggests no variation in the data for a given destination across individuals in the data set. Third, due to lack data on subjective evaluation of the destination alternatives, the model can not explain why people go to a specific destination. It simply summarizes attributes of the people who chose to go to each destination (Oum and Lemire, 1991).

maximizing the inter-group variance. Cluster analysis has been utilized in recreation and tourism studies to segment a market based on psychographic factors and product attributes (Kikuchi, 1986; Davis, Allen and Cosenza, 1988; Shoemaker, 1989; Ou, 1990; Gladwell, 1990; Loker and Perdue, 1992; Fodness and Milner, 1992).

Discriminant analysis is similar to the cluster analysis except the "structure" or groups are identified (hypothesized) prior to the analysis. Discriminant analysis involves deriving the linear combination of two (or more) independent variables that will discriminate best between the "a priori" defined groups. This is achieved by the statistical decision rule of maximizing the between-group variance relative to the within-group variance. Discriminant analysis can also be used to identify variables that contribute most to the classification. It has both predictive and descriptive functions. Marketing researchers have applied discriminant analysis to group the individuals (customers) into defined market segments (John, 1971; Levine, 1975; Perreault, Behrman and Armstrong, 1979; Buchanan, Christensen and Burdge, 1981; Gramann and Burdge, 1981; Harris, Driver and Bergersen, 1984).

Trip generation models estimate the volumes of trips/visits generated by different origins. They can be used to identify factors that influence number of trips/visits from different origins. Time series and structural regression models are the most often used trip generation models. Time series is used to identify a pattern or trend that may be extended into the future, assuming that the pattern of causal forces underlying a trend remain constant over time. It has been applied primarily to recreation and tourism activities for which historical series of participation are available (Clawson and Knetsch, 1966; BarOn,

1972, 1973; Geurts and Ibrahim, 1975; Stynes and Spotts, 1980; Stynes and Szcodronski, 1980; Wander and Van Erden, 1980; Canadian Government Office of Tourism, 1983).

Structural regression models relate recreation participation to a set of independent variables, such as participant or population characteristics, measures of recreation opportunities, and some interaction terms. A number of recreation and tourism studies have utilized regression models to estimate (and analyze) participation or visits (Cicchetti, Fisher, and Smith, 1973; Fiske, 1974; Christensen and Yoesting, 1976; Young and Smith, 1979; Archer, 1980; Fesenmaier, 1985).

Trip distribution models allocate recreation participation from origins to destinations. They are also used to examine factors (e.g., supply characteristics) that influence the distribution of trips/visits. Gravity models are the principal type of aggregate spatial interaction models used to explain/predict movement over space, such as travel to work, migration, information/commodity flows and recreational and tourism travel (Haynes, and Fotheringham, 1984). Gravity models presuppose a formula - tourist flows or travel demand (use) are modeled as functions of distance, cost, tourist income, recreation opportunities in the geographic area, and/or other independent variables. Over the past thirty years, gravity type of models have been used to describe and study statewide travel patterns, origin (sites) specific travel patterns, destination (sites) specific travel patterns, and the spatial structure of recreation opportunities (Ellis, 1966; Van Doren, 1967; Wennergren and Nelson, 1970; Rugg, 1972; Freund and Wilson, 1974; Bell, 1977; Perdue and Gustke, 1985; Fesenmaier and Lieber, 1987).

Gravity models have several advantages which contribute to their wide-scale use in describing and estimating recreational travel demand, and allocating use to alternative destinations/sites. Gravity models are especially good in the context of aggregated mass movement. They are simple to compute, easy to understand, and sufficiently flexible to accommodate changes in any, or all, of the variables involved. However, researchers have identified a number of disadvantages associated with the gravity models (Tiedemann and Milstein, 1966; Lowe and Moryadas, 1975; Ewing, 1980; Uysal and Crompton, 1985; Calantone, Benedetto and Bojanic, 1987). (1) The Gravity model as initially derived was based on Newtonian physics and some argue that the model is weaker in theoretical basis to explain the human spatial interaction. (2) There can be estimation biases caused by the problem of multicollinearity. (3) Although boundary areas are critical to a spatial model's performance, origin and destination zones in gravity models are frequently arbitrarily determined. (4) It is often difficult to incorporate individual explanatory variables. (5) Gravity models normally assume that the recreational sites (destinations) have adequate capacity to serve all those consumer who desire to visit. (6) Gravity models are unable to account for either multiple purpose or multiple destination trips. (7) Some view gravity models as too simplistic, because without modification they don't account for changes in the number of trips to existing destinations caused by the development/availability of new competing (substitute) destinations.

In general "gravity type models" a trip distribution element is incorporated that allocates use/visitation from origins to destinations. For example, in this study, several trip distribution/allocation models are utilized to distribute boats and boat days to regions

and counties. Wennergren and Nielsen (1970) developed a probability model based on the general gravity type formulation to project movement of recreational watercraft and to estimate visitation across destinations. Their sample was comprised of recreational boaters living in eight cities (origin) that visited 22 water based recreation sites in northern Utah. A probability model utilizing distance and amount of water at each site was formulated to generate probabilities of visitation from the different origins. Probability models based on Luce's choice axiom (1959) and Huff's model (1962), took the following form:

$$P_{ij} = \frac{S_j / d_{ij}^{\beta}}{\Sigma S_j^{\alpha} / d_{ij}^{\beta}}$$

where P_{ij} = probability of a boater from origin i selecting boating site j;
S_j = surface area of the boating site j;
d_{ij} = distance from the origin i to the boating site j;
α = a parameter which reflects the effect of surface area of the site on the number of trips to the site; and
β = a parameter which reflects the effect of distance on the number of trips to the site.

The expected number of trips by boaters from origin i to boating site j is a product of the total trips taken by boaters from the origin i and the probability of boaters selecting the site (P_{ij}), i.e.,

$$T_{ij} = O_i * P_{ij}$$

where T_{ij} = expected number of trips per season from the origin i to boating site j; and
O_i = total number of trips per season taken by all boater from the origin i .

The key issue in this approach is the method for estimating exponential parameters for travel distance and lake area for each of the eight origins. The authors used

an iterative procedure that minimizes the difference between actual and expected number of trips[8]. The exponents for travel distance ranged from 1.25 to 4.00 and exponents for lake area from .25 to 1.00 The coefficients of determination (r^2) for the model ranged from 0.351 to 0.999 for individual origins.

Saunders, Senter, and Jarvis (1981) conducted a study to forecast recreation demand in the Upper Savannah River located in Georgia. A gravity model was used to allocate demand among alternative recreation sites. Travel times from population centers to recreation sites were the primary demand allocation factors. According to the authors, "demand" was calculated for recreation sites at a (time) distance of 0.5, 1.0, 2.0, 2.5 and greater than 2.5 hours from the population centers. Demand was allocated within each travel time radius before proceeding to the next travel time radius. When more than one recreation sites capable of supplying a particular activity occurred within a single travel time radius, demand was equally allocated among the competing sites. The authors concluded that their allocation model is a relatively simple technique and recommended that it can be used by state, local, and regional planners. The authors did not report the performance of the allocation model.

Destination travel patterns on Vancouver Island were examined and modeled by Murphy and Keller (1990). Data for the study were collected from 5,120 visitors to the Island. The study estimated a distance decay function, examined perception of the destination area as an explanation of the distortion between reported and actual travel

[8] The statistical measure is r^2. The larger the r^2 the closer the predicted number of trips is to the actual observed number of trips.

behavior, and developed a probability matrix for modeling spatial travel patterns for island visitors.

The authors proposed a method to model the actual distribution of visitors which aggregated survey collected data into a matrix based on existing region travel behavior. The matrix indicated how many tourists entering each gateway district (origins) traveled to other districts on the Island. The matrix was then converted into a probability matrix of trip distribution by translating the actual visits into percentages. The "matrix percentage values" are probabilities that visitors arriving through different gateways will visit other districts. Although descriptive in nature, the matrix provides considerable information regarding the spatial distribution of travel patterns of visitors to the Island. The authors concluded that the probability matrix confirmed the distance decay relationships and provided a useful tool for planning and marketing strategies.

CHAPTER III

THE SYSTEM OF MODELS

The system of models used to estimate boating use in Michigan counties by storage segments is described in this chapter. The chapter is divided into two major sections. The first section describes the data sets that were used to estimate the models including the methods employed to collect the data, survey instruments, and population/samples. The second section specifies the structure of models, model components, and processes of constructing the models. Emphasis is placed on the function/purpose of each model and the linkages between models. A more detailed description of the process of estimating the models, including variable specification, parameter estimation, and model assumptions is provided in the next chapter along with estimates from the models.

DATA SOURCES

Three major data sets were used to estimate and evaluate models comprising the system: (1) Michigan Secretary of State Boat Registrations, (2) 1994 Michigan Great Lakes Marinas Census, and (3) 1994 Michigan Boating Survey[9].

Boat Registration Data

In 1958 the State of Michigan began requiring that "all motorboats, sailboats, privately owned rowboats over 16 feet in length, rental or commercial canoes, and all

[9] Distance and most of the boating opportunity information, such as the lake, shoreline, river, public access sites in counties, are from other secondary sources.

rental and commercial vessels propelled by any means and principally used in Michigan, must be registered" (MDNR Law Enforcement Division, 1995). Initially registration was intended as a permanent identification and no renewal was required. Currently, registrations are valid for only three years and then must be renewed. The combination of new registrations and renewals provides timely information on the type and size characteristics of Michigan's recreational boating fleet.

The Office of Secretary of State updates and maintains the registration information in a computer system. It generates monthly reports on the number of currently registered boats by county, type, length, and primary use (e.g., recreation, commercial), as well as the number of boats with expired registrations that had not been renewed. Boats with expired registrations are maintained on the computer system for two years after their registrations expire, even though they cannot be legally operated without a current registration.

The registration application/renewal form collects information that could be useful for various planning and forecasting purposes including: location of the owners' residence; the age (date of birth) of the owner; driver license number; type, age and length of the boat; type of power and fuel (e.g., diesel, gasoline); manufacturer, and; information relating to purchase and disposal of boats. Information on the county where the boat is stored during the boating season, type of storage, amount of use, or the counties where it is used are not included as part of boat registration data. A copy of the Watercraft Certificate Application Form is included in Appendix A.

1994 Michigan Great Lakes Marina Census

In 1994, the Department of Park, Recreation, and Tourism Resources at Michigan State University conducted a study to identify, locate (map coordinates), and describe all Great Lakes Coastal Marinas with capacity for 10 or more boats that regularly use the Great Lakes (Talhelm et al. 1995). On-site interviews with marina operators were conducted between July and October 1994 to collect information about each marina. An initial list of 646 marinas was developed from a variety of different lists including: marina permits, boating industry membership lists, and various nautical charts and marine service directories. Some of the marinas identified were found to be no longer in business and others had been merged to form larger marinas. Additional marinas were located through word-of-mouth and field observations.

The following information was collected about the 626 operating marinas: (1) type of ownership - public, commercial, or private club, (2) number and size of seasonal rental, condominium and transient slips, (3) number of moorings and dry stack storage spaces, (4) occupancy rates for different size slips, moorings and dry stack spaces, and (5) marina services provided.

1994 Michigan Boating Survey

In addition to the Marina Inventory, the Department of Park, Recreation, and Tourism Resources also conducted a state-wide survey of the owners of recreational watercraft with valid Michigan registrations as of July 1, 1994[10]. A sample of 6,000

[10] Boats whose registration certificates would not expire before the end of the 1994 boating season. The procedure of estimating boats with valid registrations was discussed in detail in the report of 1994 Michigan Boating Survey (Stynes et al., 1995).

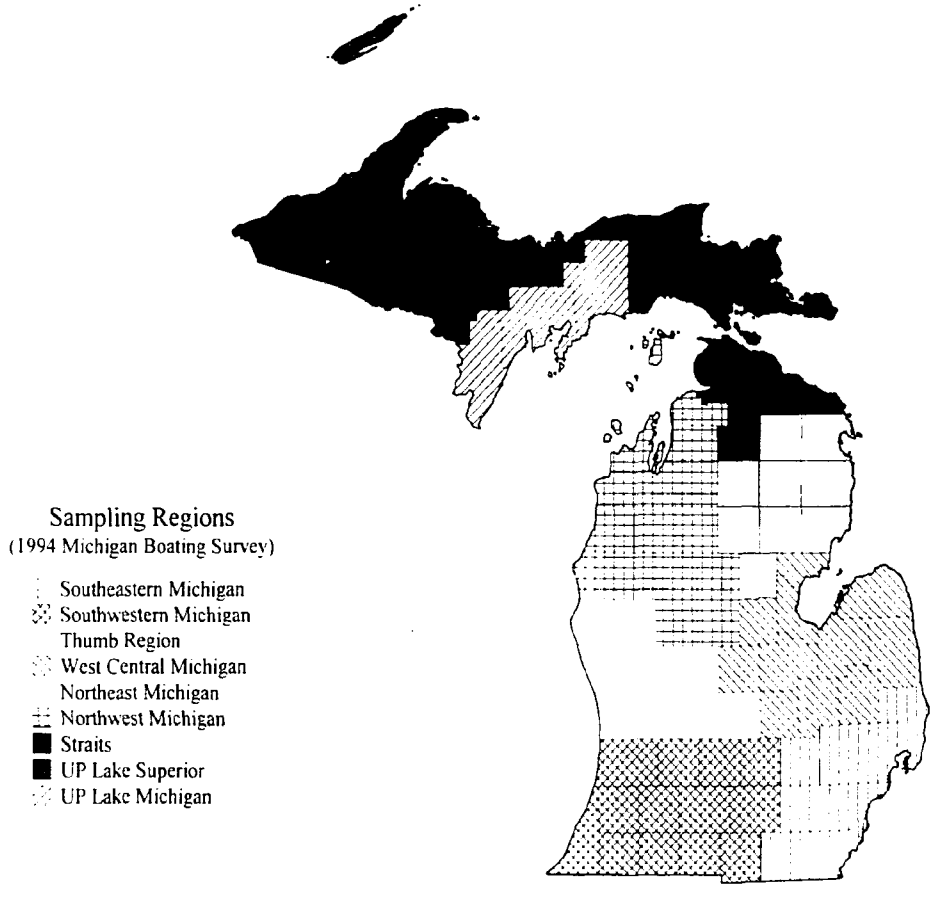
registered boats, stratified by length (< 16 feet, 16-20 feet, 21-28 feet, and 29+ feet) and geographic regions (ten boating regions) was drawn from the Secretary State's list of registered boats[11]. The sample was stratified to assure adequate samples for different regions and size classes.

A four page questionnaire was mailed to the 6,000 registered boat owners at the end of the 1994 boating seasons (October 7th, 1994). A follow-up questionnaire was sent by certified mail three weeks later to non-respondents. Of the 6,000 questionnaires sent, 5,638 were delivered and 3,909 (69%) were returned. Returns included 2,980 boats that were used during the 1994 season, 743 boats that were not used during the season, and 186 unusable questionnaires (e.g., significantly incomplete, completed for two boats).

The questionnaire collected information on: (1) characteristics of boats, boat owners, and boat owner households, (2) where the boat was stored during the 1994 boating season including county and type of storage, e.g., marina, second home, (3) seasonal and temporary use of marinas and launching facilities, (4) 1994 boat days on the Great Lakes and inland lakes and rivers in different counties, and (5) spending on equipment, repairs, insurance, storage, and fuel (Appendix B). A brief summary of the findings was presented in Chapter two. For a more detailed discussion of the survey's methods and findings see Stynes et al., 1995.

[11] Boating regions are adopted from the Great Lakes market regions used in the 1980 Michigan Boater Survey (Stynes and Safronoff 1982). (see Figure 2)

Figure 2. 1994 Michigan Boating Survey Sampling Regions.



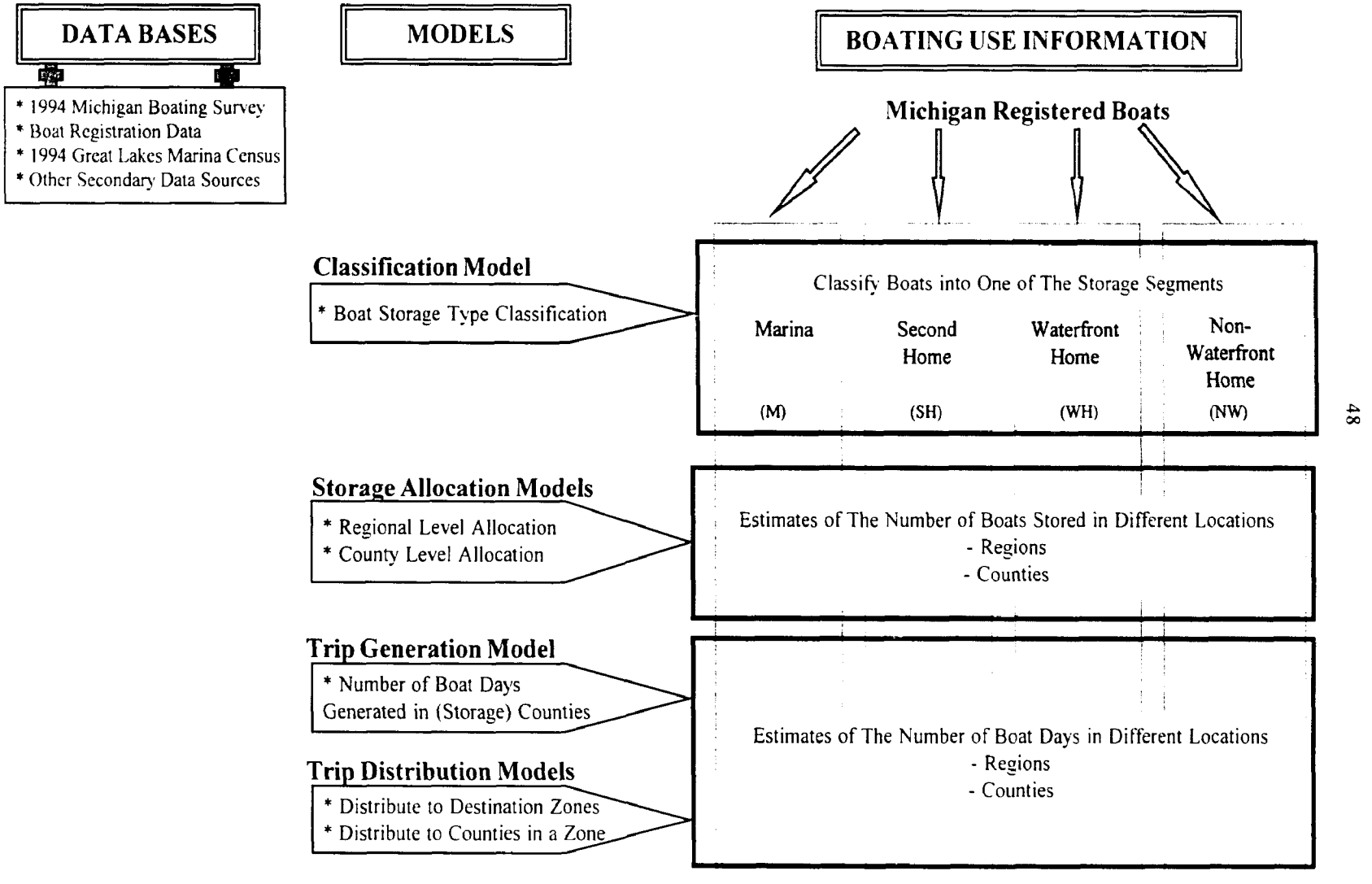
THE SYSTEM OF MODELS

There is no direct way to estimate county level boating use, or the number of boats stored by county from any existing data source. No agency or organization collects information that provides estimates of boat use by region or county. Boat registration data provide no information about storage or use. The sample size for the 1994 Michigan Boating Survey is too small to yield reliable estimates of boating use for most counties. However, a system of models can be developed from a combination of different data sources. The models can be used to estimate: (1) the number of registered boats kept in different types of storage during the boating season, (2) the number and sizes of boats kept in counties during the boating season, (3) the number of boat days by boats kept in counties, and (4) ultimately the location(s) where these boat days take place. The different types of models comprising the system relate boat registration information first to types of storage and counties where the boats are kept during the boating season, and ultimately to the counties where the boats are used (Figure 3).

The system of models utilizes and combines a variety of different types and sources of "demand" and "supply" data including estimates produced by other models in the system. In most instances the secondary data provide a means or basis for estimation or allocation, rather than direct estimates. For example, data on boating facilities and amount of recreation boating water (number of lakes) are used to geographically allocate (estimates of) days of boating by boats kept in (origin) counties since no source of information is available on how boat days are distributed throughout the state.

Four different types of models comprise the system of models: (1) a classification model, (2) storage allocation models, (3) a trip generation model, and (4) trip distribution

Figure 3. The System of Models.

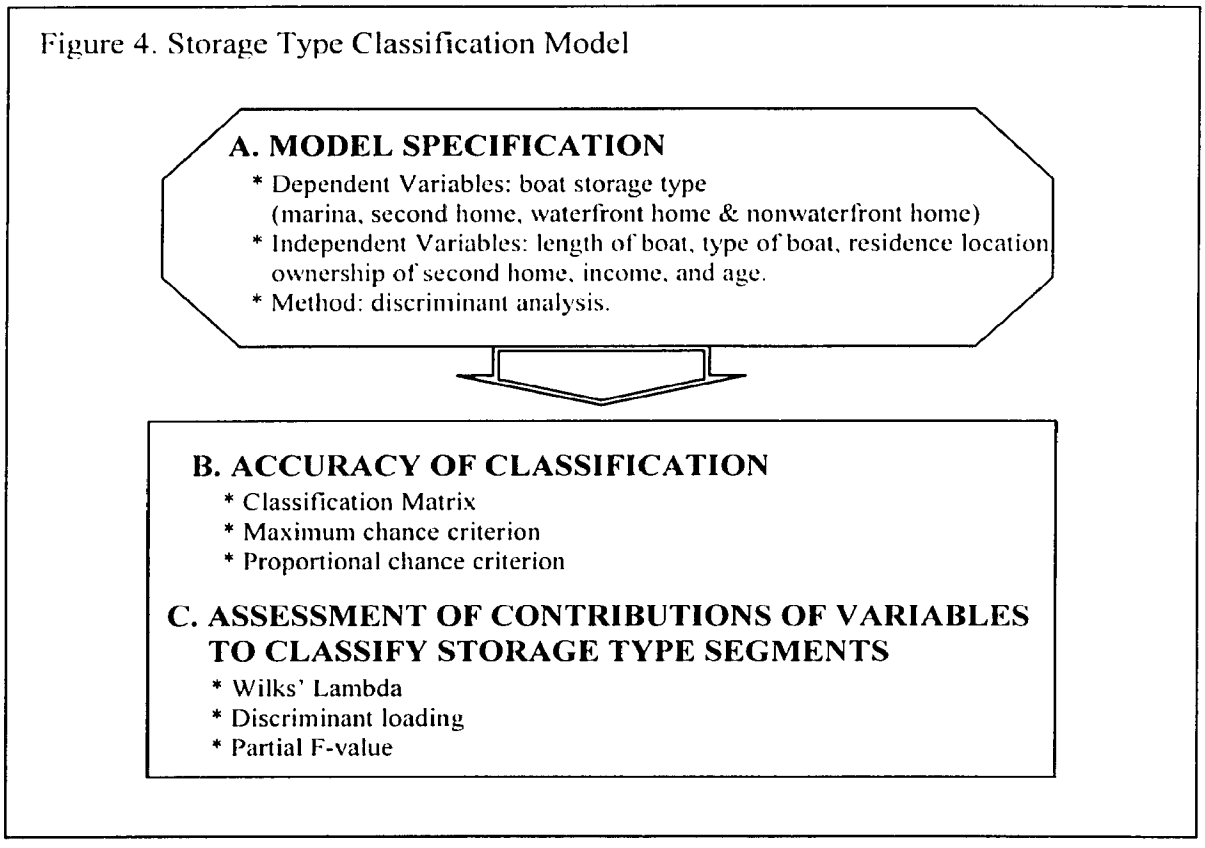


models. The sequence and linkages between models is shown in Figure 3. The figure also shows the various types of estimates produced by the models.

Classification Model

The function of the classification model is to classify registered boats into different types of storage where the boats are kept during the boating season. The four types of storage are: (1) marinas, (2) seasonal homes, (3) permanent waterfront homes, and (4) non-waterfront permanent home (Figure 4).

Figure 4. Storage Type Classification Model



A discriminant analysis is employed to classify individual boats into the four "types of storage segments" on the basis of information/variables from the Boat Registration Data and the 1994 Michigan Boating Survey. The discriminant analysis also identifies which of the (independent) variables contribute to the classification. Discriminant analysis includes both predictive and descriptive functions and involves three steps/stages: (1) derivation, (2) validation, and (3) interpretation. The "*derivation stage*" consists of selecting variables and determining whether or not a statistically significant function can be derived to separate groups. In the "*validation stage*" a classification matrix is developed to evaluate the predictive accuracy of the discriminant function. The "*interpretation stage*" involves determining which independent variables contribute the most to discriminate among the groups. The model provides classification of boats in different storage segments.

Storage Allocation Models

The purpose of the second set of models is to allocate boats within each storage segment to the counties where they are kept during the boating season. A two step approach is utilized to estimate the number of boats in different storage segments kept in different counties. Boats are first allocated to one of the regions where the boats are kept, and then to the counties within each region. A two step process is required because even the 3000 useable returns to the 1994 Michigan Boating Survey are not sufficient to generate reliable estimates of boats stored in all 83 counties. Small sample sizes for many counties would have resulted in large sampling errors. However, an adequate number of surveys are available to generate reasonably reliable estimates of boats stored in different

regions. The ten regions include six coastal regions, two inland regions and two Upper Peninsula regions. The regions are mapped in Figure 5.

The distribution (percentage) of boats within different storage segments and size classes is estimated from the 1994 Michigan Boating Survey. This distribution is used to estimate number of boats stored in the regions. There are two reasons to incorporate boat size into the allocation scheme: (1) the Boat Registration Data provides information on the size of boats registered in counties, and (2) length of boats is an important factor in estimating the average number of days boats are used.

Boats are allocated to storage counties within regions based on the county's share of boat-storage opportunities available in the region. The following formula is used to allocate boats to counties:

$$T_{(i|r)} = \frac{S_i}{\sum_{i \in \text{Region } r} S_i}$$

where $T_{(i|r)}$: total number of boats kept in county i, given region r; and
S_i : availability of boat storage opportunities in county i.

Different measures of available boat storage are used for each storage segment. Boats stored at marinas in the Great Lakes coastal regions, are distributed to the counties based on the county's share of marina spaces in the region (Figure 6). Boats stored at marinas in the inland regions, are allocated to counties on the basis of the number of inland lakes over 50 acres and total acres of inland lakes in the county (Figure 6), because there is no available estimate of the number or capacity of inland marinas. Acres of large lakes is considered a reasonable indicator of the number of inland marinas spaces in the counties. Boats stored at seasonal homes are distributed according to the estimated

Figure 5. Michigan Boating Regions (I)

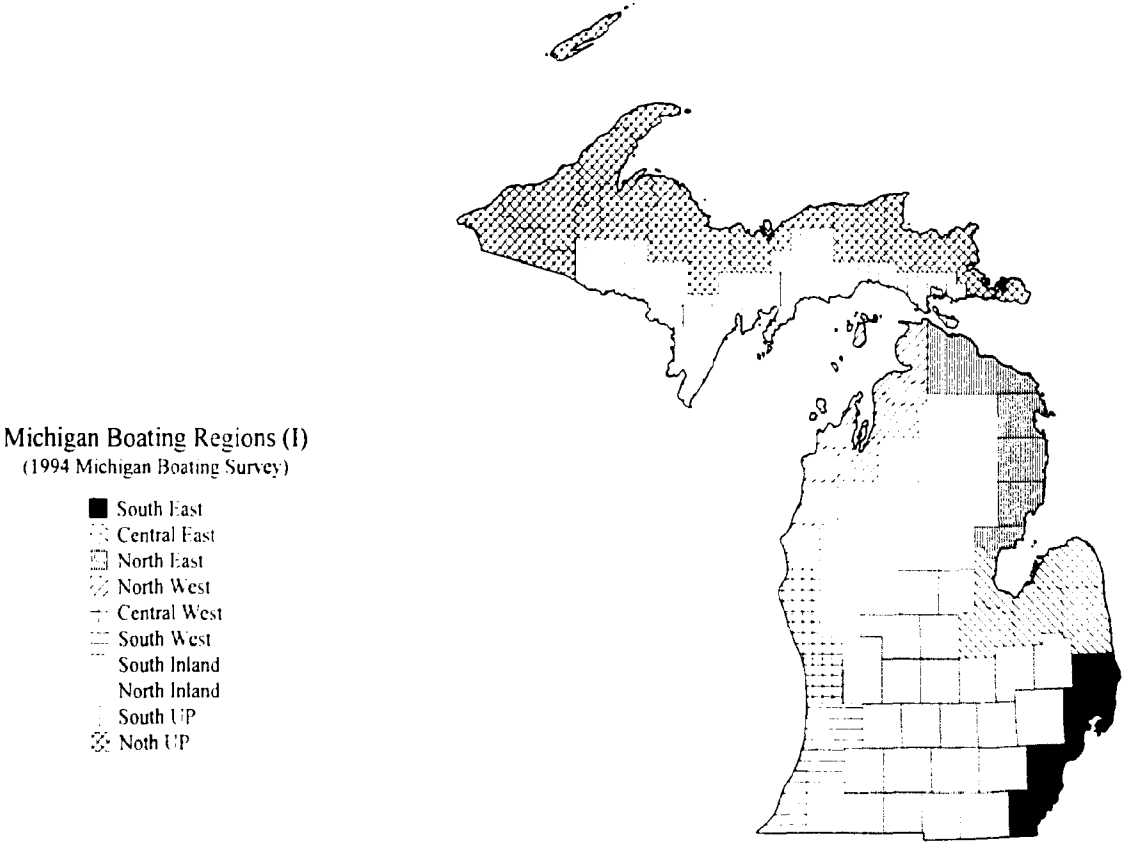
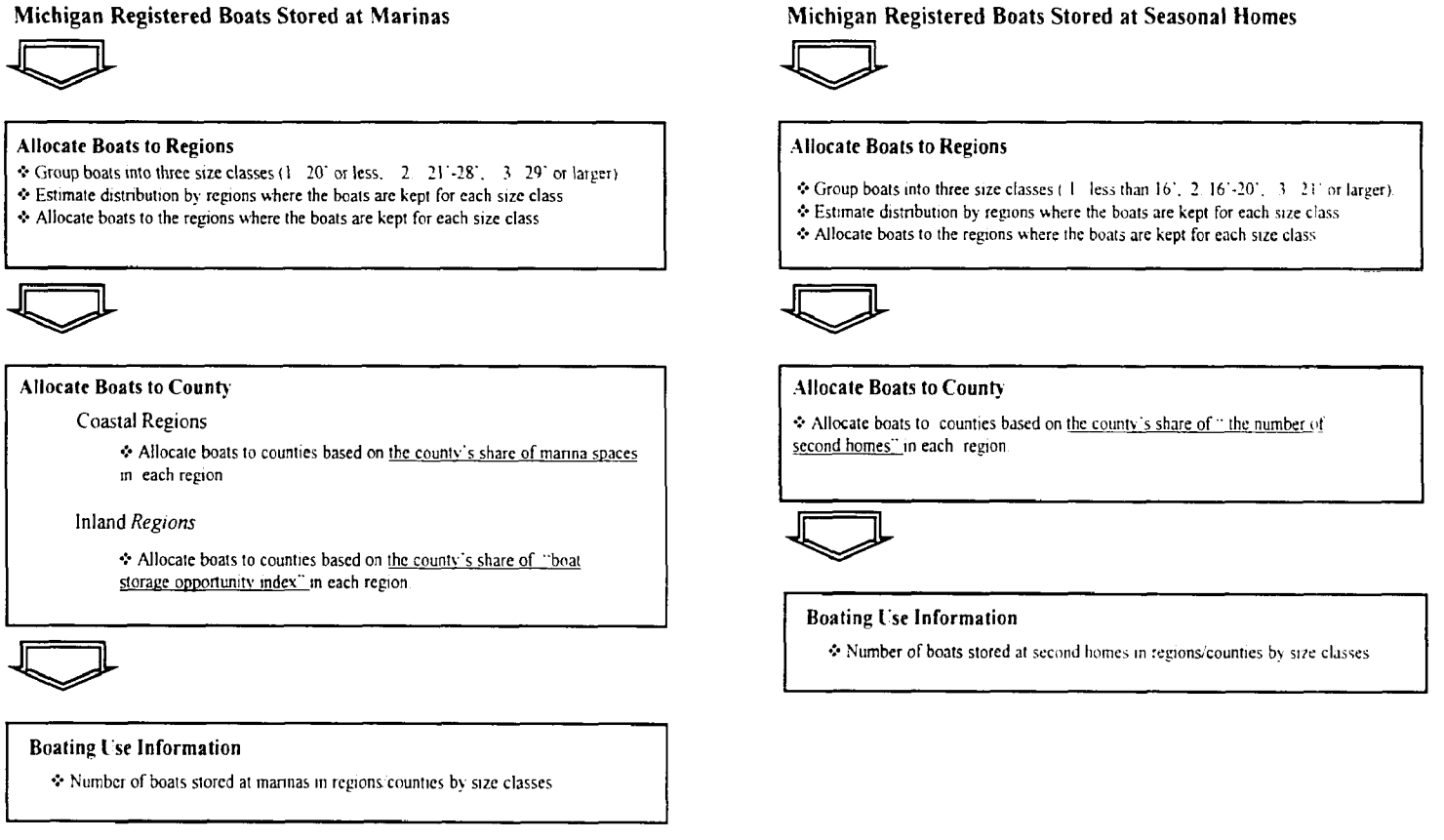


Figure 6. Storage Allocation Models for Boats Stored at Marinas and Second Homes.



number of seasonal homes in each county (Figure 6). Finally, boats stored at waterfront and nonwaterfront permanent homes are allocated to counties based on the number of boats of different sizes registered in the county (Figure 7). County of registration is used because with few exceptions the permanent home is the same as the registration address.

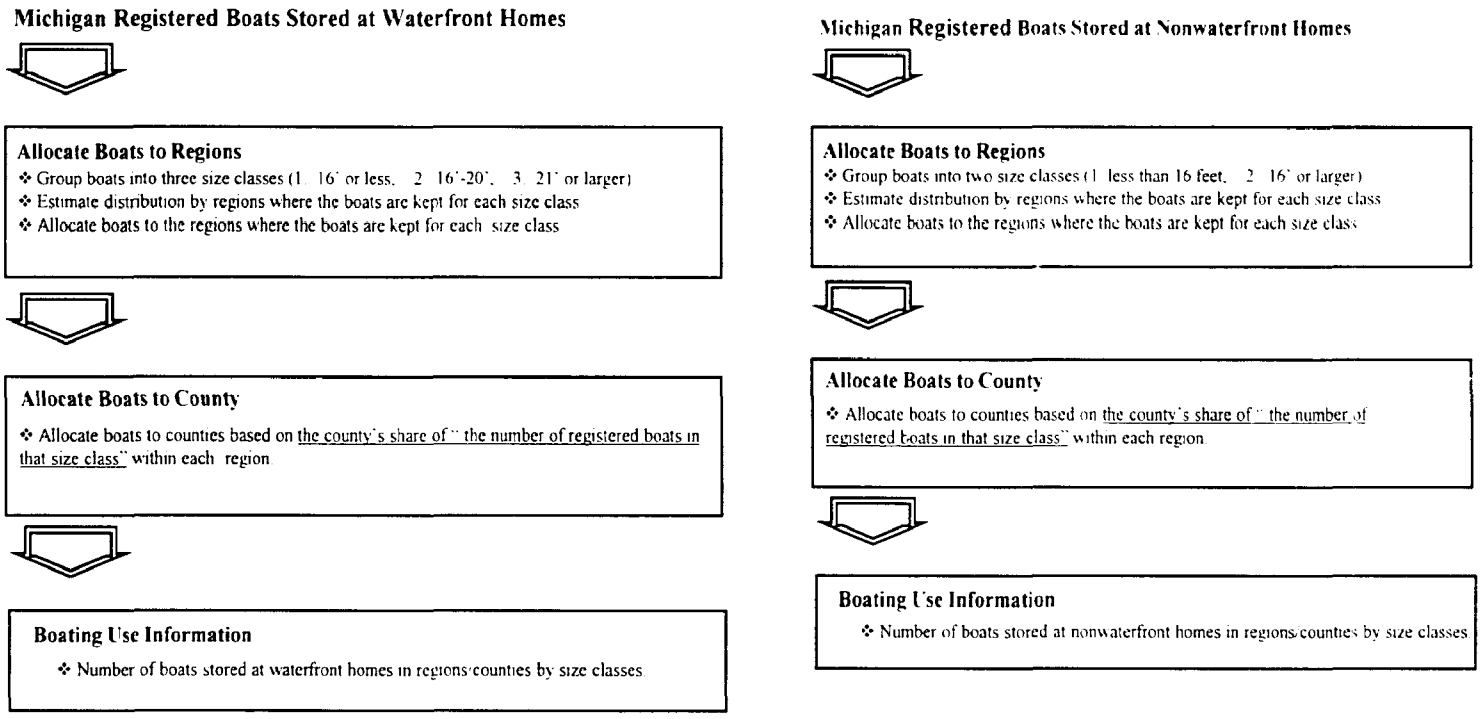
Trip Generation and Trip Distribution Models

The final component of the system of models consists of a trip generation model and a set of trip distribution models. The function of these models is to: (1) estimate the number of boat days in (destination) counties by boats in different types of storage, and (2) model trip patterns from origin counties (boat storage locations) to destination counties (boat use location). The trip generation models estimate the number of boat days generated by boats stored in each county by storage segments. The trip distribution models distribute these boat days to different (destination) counties.

Total days by boats in each storage segment is computed by multiplying the average number of boat days within different size classes and storage segments times the number of boats kept in each county. The average number of boat days for different size classes and storage segments is estimated from the 1994 Michigan Boating Survey data. Estimates of total days generated in each county are the primary input to the trip distribution model.

Different approaches are employed to distribute days by boats in different storage segments to (destination) counties. The models to distribute days by boats stored at second homes and permanent waterfront homes are relatively straightforward. Results of 1994 Michigan Boating Survey show that almost all of these boat days (97% for boats kept at second homes and 95% for boats stores at permanent waterfront homes) are

Figure 7. Storage Allocation Models for Boats Stored at Waterfront Homes and Nonwaterfront Homes.



inside the county where they are stored during the boating season. Thus, the model distributes all boat days by boats in these two storage segments to the counties where they are kept during the boating season.

Boat days by boats kept at marinas located in inland counties are all allocated to the county where the marina is located. Given that it is generally inconvenient and expensive to move and transport large-sized marina boats to other counties, it is assumed that almost all boat days generated by boats stored at inland marinas stay within the county of storage.

A more complex two-step trip distribution model is required for boats stored at marinas in Great Lakes coastal counties, and boats stored at permanent non-waterfront homes. Boats stored at non-waterfront homes are frequently trailered to different counties where they are used. Boats stored at Great Lakes marinas are often operated in adjacent counties and/or along popular Great Lakes cruising routes. Information (e.g., trip origins) on boats that rent transient slips indicates that larger craft stored on the Great Lakes often travel considerable distances on Great Lakes cruises (Stewart and Stynes, 1990).

The two step approach first distributes boat days to concentric (destination) zones around each (storage) county and then to the counties within these zones. An estimated distribution of boat days within different destination zones is used to distribute days of boating to each destination zone. The estimates are derived from the 1994 Michigan Boating Survey. Boat days are distributed to counties within a destination zone based on the county's share of boating use opportunities available in the zone. The following formula is used to distribute boat days to counties within destination zones:

$$D_{(i|z)} = \frac{U_i}{\sum_{i \in \text{Destination zone } z} U_i}$$

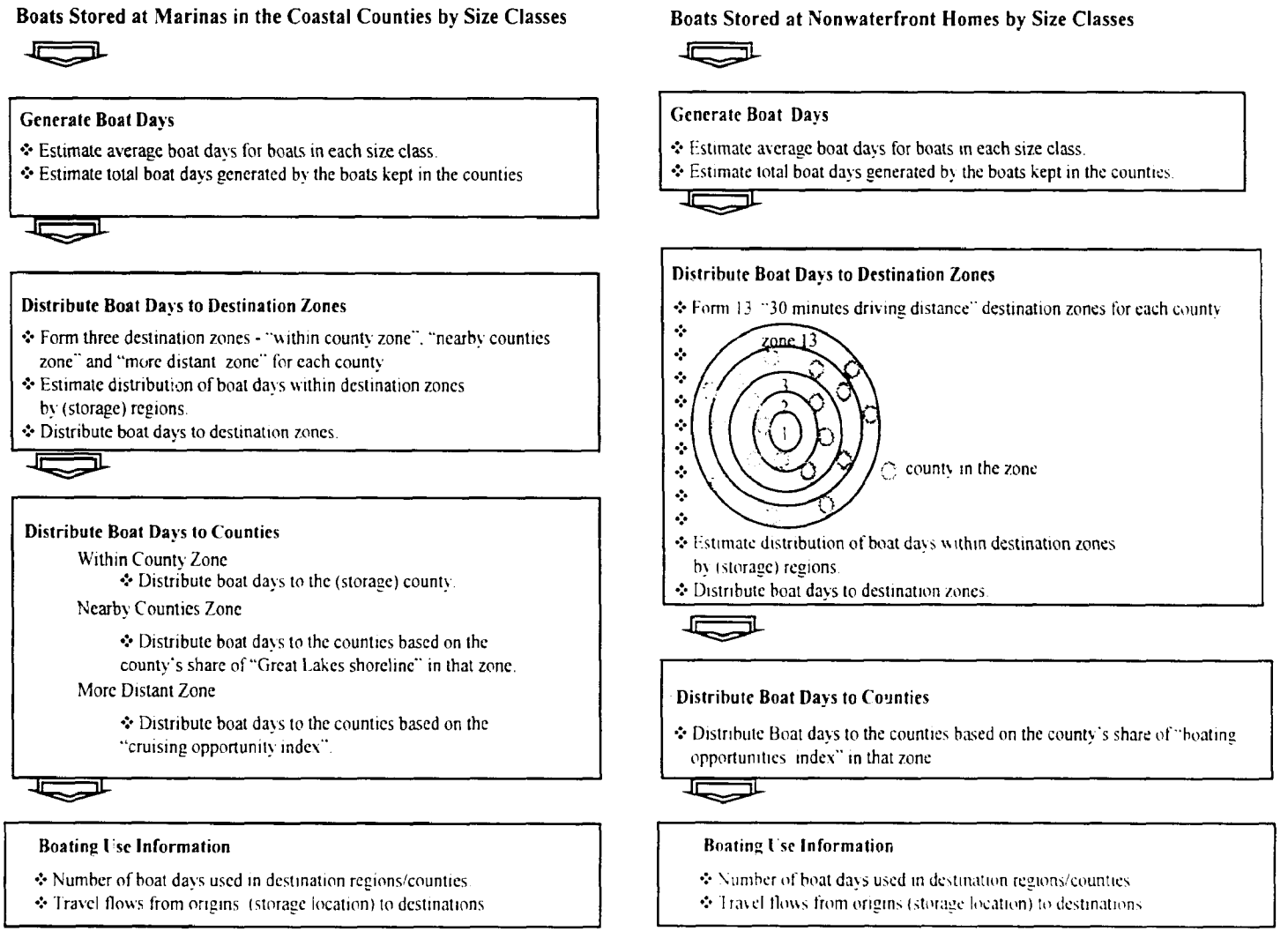
where $D_{(i|z)}$: number of boat days in destination county i, given destination zone z; and
U_i : availability of boating-use opportunities in county i.

Previous boating studies indicate that the propensity to travel and boating use patterns differ among boats in different storage segments. Based on these findings different (concentric) destination zones and different measures of county boating use opportunities are formulated for boats kept at coastal marinas and those stored at nonwaterfront permanent homes (Figures 8).

Three destination zones are established for boats stored at coastal marinas -- (1) *within county*, (2) *nearby counties*, and (3) *more distant counties*. Results from the 1994 Michigan Boating Survey showed the two primary uses of boats kept at Great Lakes marinas are pleasure boating in the county where the marina is located or adjacent counties, or "cruising" to more distant counties. Miles of Great Lake shoreline are used to distribute boat days to nearby counties. A cruising attraction/opportunity index that combines the number of transient slips in counties and the number of nights these transient slips are rented is used to distribute boat days to the counties within "more distant counties" destination zone.

The model that distributes days by boats stored at nonwaterfront permanent homes utilizes 30 minute/mile driving zones. It is based on the assumption that: (1) boating use decreases as trailering distance from storage county increases, and (2) propensity to

Figure 8. Trip Generation and Distribution Models for Boats Stored at Marinas in Coastal Counties and Nonwaterfront Homes.



travel/trailer is constant within zones. A boating opportunity index, based on weighted measures of boating resources and facilities in the county, is the basis for distributing boat days to the counties within the (30 minute) destination zones (Figure 8).

CHAPTER IV

MODEL SPECIFICATIONS AND RESULTS

This chapter presents estimates of boating use produced by the system of models. The models are presented in three major sections: (1) boat storage classification, (2) boats kept in the counties, and (3) boat days in the counties. Each section reports the results from one or more individual models. The presentation of the individual models includes: (1) model specification, (2) assumptions of model, (3) results of model, and (4) evaluation of model. A summary of the results and evaluation of all models are provided at the end of the section.

BOAT STORAGE CLASSIFICATION

Discriminant analysis is used to classify boats into one of four storage segments: (1) marinas, (2) second homes, (3) waterfront homes, and (4) nonwaterfront homes. The results of the discriminant analysis are presented in three stages: (1) model specification, (2) results and model evaluation, and (3) interpretation.

Model Specification

The model specification stage identifies the dependent and independent variables. Storage segment (marina, second home, waterfront home, and nonwaterfront home) is used as the dependent variable in the analysis. Boats that were active in 1994 whose owners returned 1994 Michigan Boating Survey are assigned to one of the four segments

based on "types of storage facilities"[12] (marina, second home, and permanent residence) and "type of storage location"[13] (waterfront location vs. non-waterfront location). Boats kept at "other" types of storage facilities, and boats (cases) with missing storage information are excluded from the analysis. The resulting "storage segments" are: (1) marinas, (2) second homes, (3) permanent waterfront homes, (4) permanent non-waterfront homes (Table 6). The four storage segments are mutually exclusive and exhaustive.

The characteristics of boats and boat owners that are used to predict boat storage segments include (1) length of boat, (2) type of boat[14], (3) location of the owners' residence[15], (4) ownership of a second home, (5) age of boat owners and (6) income. Type and length of boat, and owner's address are part of the boat registration data collected by the Office of Secretary of State.

The characteristics of the boats and boat owners vary considerably between storage segments. Most boats stored at marinas are large, averaging 31 feet in length. Most (95%) of the boats in this segment are inboards or sailboats. Boats stored at nonwaterfront homes tend to be smaller craft with an average length of 17 feet.

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[12] The 1994 Michigan Boating Survey collected information on five types of seasonal storage: (1) permanent residence, (2) a cottage or second home, (3) a rented space in a public marina, (4) a rented space in a commercial marina, (5) an owned space in marina or dockaminium or (6) other storage type (e.g., friends home, commercial rental facility). Rented spaces at public, private and commercial marinas, and condominium or dockaminium spaces are combined into a marina storage category.

[13] The 1994 Michigan Boating Survey collected information on the location of seasonal storage: (1) at a waterfront site with access to the Great Lakes, (2) at an inland lake waterfront site, (3) at a river or stream waterfront site or (4) non-waterfront site. The three waterfront sites are combined into a waterfront location category.

[14] Types of boat are re-grouped into inboards, outboards, sailboats, pontoon boats and canoes.

[15] Locations of residences are grouped into seven regions: south-coast region, central-coast region, north-coast region, Upper Peninsula and out-of-state.

Table 6. 1994 Michigan Boating Survey Sample Sizes for Different Storage Segments.

	SAMPLE		POPULATION ESTIMATE	
Boat Storage Segments[a]	Number of Boats	Percent	Number of Boats	Percent
Marina	984	35.7	59,077	11.6
Second Home	574	20.8	134,072	26.3
Waterfront Home	593	21.5	119,187	23.4
Nonwaterfront Home	603	21.9	196,686	38.6
Total	2,754	100	509,022	100

a. Cases with missing storage facility or storage location information are excluded from the analysis.

Two thirds (68%) of these boats are outboard motor boats. Owners of boats kept at second homes are the oldest with an average age of 59. Approximately 88% of them own a second home, and 32% are out-of-state residents. The owners of boats stored at nonwaterfront homes are the youngest averaging 51 years of age. Only 13% own a second home, and about half of them reside in southern Michigan (Table 7).

Results and Model Evaluation

Overall, 69% of the boats are correctly classified (Table 8). The discriminant analysis correctly classifies 84% of boats stored at second homes, 76% of boats stored at marinas, 69% of boats stored at nonwaterfront homes, but only 44% of boats stored at waterfront homes.

The classification matrix (Table 8) shows correct classifications in the diagonal cells and incorrect classifications in the off-diagonal cells. Table 9 profiles the cases that are correctly and incorrectly classified for each storage segment. The model incorrectly classifies 10% of marina boats into the second home segment, and 11% into the waterfront home segment. The mis-classified marina boats are smaller and more are outboards or pontoon boats. The owners of the mis-classified boats are on average older, they are more likely to own a second home, and have a lower average incomes compared to the owners of correctly classified boats.

The model incorrectly classifies 7% of second home boats into the marina segment, and 6% into the nonwaterfront home segment. Those mis-classified second home boats are larger and/or more are sailboats. Their owners are younger, less likely to own a second home, and/or have a lower average incomes compared to other group

Table 7. Characteristics of Boat and Boat Owner by Storage Categories.

	STORAGE SEGMENTS				ALL BOATS
	Marina	Second Home	Waterfront Home	Nonwaterfront Home	
	Mean	Mean	Mean	Mean	Mean
Boat Length (feet)	30.77	20.28	21.76	16.66	23.59
Boat Type					
Inboard Boat	60%	42%	41%	22%	44%
Outboard Boat	3%	28%	26%	68%	27%
Sail Boat	35%	7%	8%	1%	16%
Pontoon	2%	17%	21%	1%	9%
Canoe	0%	5%	3%	6%	3%
Residence Location					
South Coast	16%	10%	17%	13%	14%
Central Coast	14%	7%	7%	15%	11%
North Coastal	15%	5%	24%	14%	15%
South Inland	31%	36%	26%	37%	32%
North Inland	4%	3%	12%	10%	7%
Upper Peninsula	10%	7%	13%	11%	10%
Out of State	10%	32%	0%	0%	10%
Income					
Under $20,000	6%	12%	15%	21%	12%
$20,000-$59,000	42%	39%	51%	56%	46%
Over $60,000	45%	38%	24%	15%	33%
Age of Owner (years)	52.75	59.20	57.25	51.16	54.72
Own a Second Home	21%	88%	16%	13%	33%

Table 8. Classification Matrix for Comparing Number of Boats in Storage Segments Predicted by the Model with 1994 Michigan Boating Survey.

	DISCRIMINANT ANALYSIS Predicted Segment Members				
	Marina	Second Home	Waterfront Home	Nonwaterfront Home	Total
1994 SURVEY RESULTS					
Marina	748	102	112	22	984
(pct.)	**76%***	10%	11%	2%	
Second Home	42	481	18	33	574
(pct.)	7%	**84%***	3%	6%	
Waterfront Home	107	83	260	143	593
(pct.)	18%	14%	**44%***	24%	
Nonwaterfront Home	10	71	106	416	603
(pct.)	2%	12%	18%	**69%***	
Model Predicted (total)	907	737	496	614	2,754

SUMMARY STATISTICS

Percent of cases correctly classified	69.17%
Maximum chance criterion	35.70%
Proportional chance criterion	26.49%

* percent correctly classified in bold.

Table 9. Profiles of Boats (and Owners) Correctly and Incorrectly Classified into Storage Segments.

	BOAT STORAGE SEGMENTS											
	Marina			Second Home			Waterfront Home			Nonwaterfront Home		
	Correctly Classified	Incorrectly Classified	Survey Observed	Correctly Classified	Incorrectly Classified	Survey Observed	Correctly Classified	Incorrectly Classified	Survey Observed	Correctly Classified	Incorrectly Classified	Survey Observed
Boat Length (feet)	33.03	23.34	30.767	19.35	24.6	20.28	21.25	22.1	21.758	15.43	19.27	16.66
Boat Type												
Inboard Boat	57%	70%	60%	44%	32%	42%	53%	30%	41%	4%	64%	22%
Outboard Boat	0%	11%	3%	28%	32%	28%	0%	46%	26%	89%	23%	68%
Sail Boat	43%	9%	35%	4%	23%	7%	2%	13%	8%	0%	4%	1%
Pontoon	0%	9%	2%	18%	10%	17%	43%	5%	21%	0%	4%	1%
Canoe	0%	0%	0%	5%	3%	5%	1%	5%	3%	7%	4%	6%
Residence Location												
South Coast	16%	17%	16%	11%	4%	10%	16%	18%	17%	14%	13%	13%
Central Coast	15%	10%	14%	7%	12%	7%	3%	9%	7%	15%	12%	15%
North Coastal	16%	14%	15%	5%	9%	5%	23%	25%	24%	14%	14%	14%
South Inland	35%	21%	31%	34%	42%	36%	29%	24%	26%	37%	34%	37%
North Inland	3%	6%	4%	3%	7%	3%	16%	11%	12%	11%	12%	10%
Upper Peninsula	8%	14%	10%	5%	14%	7%	13%	12%	13%	9%	15%	11%
Out of State	7%	19%	10%	36%	12%	32%	0%	0%	0%	0%	0%	0%
Income												
Under $20,000	5%	11%	6%	11%	16%	12%	17%	14%	15%	22%	20%	21%
$20,000-$59,999	40%	46%	42%	38%	41%	39%	56%	47%	51%	57%	51%	56%
Over $60,000	47%	35%	45%	39%	28%	38%	18%	29%	24%	12%	20%	15%
Age of Owners (years)	51.84	55.52	52.751	60.54	52.52	59.198	58.67	56.35	57.251	50.39	53.19	51.16
Own a Second Home	15%	42%	21%	98%	31%	88%	0%	30%	16%	1%	39%	13%

members. The model incorrectly classifies 12% of nonwaterfront home boats into the second home segment and 18% into waterfront home segment. The mis-classified nonwaterfront home boats are larger and/or are more likely to be inboards. Their owners are older, more likely to own a second home, and/or have a higher average incomes compared to other group members.

Over 50% of boats stored at waterfront homes are incorrectly classified into other storage segments. The discriminant analysis can not accurately classify boats kept at permanent waterfront homes based on the independent variables that were used in this analysis. A major reason for the inability to correctly classify waterfront home boats is that the boats and their owners have similar characteristics with boats in other storage segments. Boats stored at waterfront homes are similar in types and size to boats stored at second homes. There are few differences between boats stored at permanent waterfront homes and nonwaterfront homes. Their owners have similar incomes and propensity for second home ownership.

There is no universal standard for accepting or rejecting a discriminant function based on predictive accuracy of group classification. Two different criterion, the *maximum chance criterion* and the *proportional chance criterion*, suggested by Hair, Anderson and Tatham (1987) are used to evaluate predictive accuracy. *The maximum chance criterion* requires that the percent of correct classification of the discriminant analysis is higher than the percent of group members in the largest group[16]. In this study,

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[16] We could arbitrarily assign all subjects to the largest group and achieve certain percent of accuracy, which is the same as percent of total subjects in the largest group, without the aid of discriminant functions. Therefore, if the percent of correct classification for the discriminant functions do not exceed "the percent" of subjects in the largest group, it has not helped us predict, based on this criterion.

the percent of correct classification of the discriminant analysis is 69%, about double the maximum chance criterion, 36% (Table 8). According to this criterion, the discriminant analysis classifies boats into the storage segments reasonably well.

The proportional chance criterion takes into account the ability of discriminant functions to classify correctly subjects/objects into smaller size groups as well as the largest group. The proportional chance criterion requires the percent of correct classification from a discriminant analysis to be higher than $C_{proportional}$. The formula for this criteria is

$C_{proportional} = \Sigma p_i^2$, where p_i = the proportion of subjects in group i .

In this study, the percent of correct classification (69%) is much higher than *the proportional chance criterion* (26%) (Table 8). Based on this criterion, the discriminant analysis adequately predicts boats in different storage segments.

Interpretation

Discriminant loadings, Wilks' lambda, and partial F are used to evaluate the relative importance of independent variables to discriminate among the groups. The discriminant loading, or structure correlation, measures the simple linear correlation between independent variables and discriminant functions[17] (Table 10). The greater the absolute value of a discriminant loading, the stronger the relationship between that variable and the discriminant function. The sign of a discriminant loading indicates the positive or negative correlation between the independent variables and the discriminant

[17] Three discriminant functions generated by discriminant analysis are used to classify boats into storage segments. The discriminant functions are linear combination of independent variables that will discriminate best between the priori-defined groups. This is achieved by the statistical decision rule of maximizing the between group variance relative to the within-group variance.

Table 10. Discriminant Loading for Independent Variables Comprising The Discriminant Functions.

	Discriminant Function		
	I	II	III
Boat Length (feet)	.88991*	0.15440	0.02614
Outboard Boat	-.53208*	-0.30334	0.46679
Sail Boat	.38831*	0.05882	0.16038
Inboard Boat	.25932*	0.12419	-0.08968
Income Over $60,000	.19134*	0.15846	0.15061
Canoe	-.13860*	-0.01745	0.03407
Income Under $20,000	-.12842*	-0.06929	-0.10976
Second Home Ownership	-0.24676	.83913*	0.04938
Reside Out of State	-0.04344	.48713*	0.15510
Income $20,000 to $59,999	-0.08181	-.11799*	-0.05469
Pontoon Boat	-0.11097	0.13042	-.69681*
Age of Boat Owner	-0.06654	0.17825	-.38564*
Reside in Central Coast Region	0.04454	-0.06222	.24834*
Reside in North Inland Region	-0.08829	-0.08118	-.21080*
Reside in North Coast Region	0.06006	-0.15418	-.20144*
Reside in South Inland Region	-0.03795	0.02715	.17919*
Reside in Upper Peninsula Region	0.00067	-0.11579	-.17424*
Reside in South Coast Region	0.04729	-0.05973	-.08499*

* Indicates that the correlation between the independent variable and discriminant function is significant at 0.05 level.

functions. Discriminant function I may be interpreted as a function to differentiate between boats stored at marinas and boats in other types of storage. Boat length, sail, inboard powered, and income over $60,000 are positive correlated with the discriminant function I. Discriminant function II may be interpreted as a function to differentiate between boats stored at second homes and boats in other types of storage. Second home ownership, and out-of-state residency are positively correlated with the discriminant function II. Discriminant function III may be interpreted as a function to differentiate between boats stored at nonwaterfront homes and boats in other storage segments. Pontoon boats, age of the owners, and whether the owners reside in northern-inland, northern-coastal or Upper Peninsula regions, are negatively correlated with the discriminant function III.

Wilk's lambda and partial F value are utilized to determine the impacts of independent variables on the classification (Table 11). The Wilks' lambda which is the ratio of the within-groups sum of squares to the total sum of squares measures the discriminating power of a variable. The larger the Wilks' lambda, the stronger the discriminant power of the independent variable. A partial F-value is obtained for each independent variable, where it partitions out the variance in the variable that is already explained by the other variables. Larger F-values indicate independent variables with greater discriminating power. Boat length, second home ownership, and outboard power have the strongest influences in classifying boats into storage segments.

The discriminant model is a disaggregate level of analysis, as it predicts storage of individual boats (i.e., "does the discriminant model classify boat "x" that is stored at a marina as a marina stored boat?"). For most planning and marketing decisions it is

Table 11. Wilks' Lambda and Partial F for Independent Variables in The Discriminant Analysis.

Independent Variables[a]	Wilks' Lambda	Partial F
Boat Length (feet)	0.527	791.85
Second Home Ownership	0.333	645.68
Outboard Boat	0.304	451.64
Reside Out of State	0.282	357.95
Pontoon Boat	0.261	304.52
Sail Boat	0.252	260.53
Age of Boat Owner	0.247	226.33
Reside in South Inland Region	0.244	200.29
Reside in Central Coast Region	0.240	180.11
Inboard Boat	0.238	162.99
Reside in South Coast Region	0.237	148.57

a. The independent variables entered in stepwise discriminant analysis based on the rule of minimizing overall Wilks' lambda.

necessary to predict boat storage at an aggregate level (i.e., "how many boats in size class "x" are stored at marinas?"). At the disaggregate level, the discriminant model correctly classifies 748 (76%) of the 984 boats stored at marinas. At the aggregate level, the discriminant model predicts 907 boats stored at marinas. This is 8% less than the 1994 Michigan Boating Survey estimate of 984 boats.

Except for the discriminant model, other models in the system (i.e., storage allocation models and trip distribution models) are estimated at the aggregate level and they are evaluated accordingly. The aggregate models first group individual boats into classes based on region, county, size class or segment and then model boating use of the group as a whole. The estimated parameters from the discriminant analysis can not be used directly in the allocation models based on the Boat Registration data, because the primary independent variable, second home ownership, is not measured in the data set.

BOATS STORED IN COUNTIES

Spatial allocation models are used to allocate boats within each of the storage segments to counties where they are kept during the boating season. A two step approach is employed: boats first are allocated to storage regions, and then to counties within each region. The allocation models for each storage segment are summarized in Figure 6 and 7 (on pages 53 and 55).

Model Specification

The number of boats in each size class is estimated from 1994 Michigan Boating survey for each storage segment. Boats stored at nonwaterfront homes comprise almost

40% of the active registered boats. Two thirds of these boats are less than 16 feet. Almost half of Michigan's registered boats are stored at either second homes (26%) or waterfront homes (23%). Approximately 12% of active registered boats are stored at marinas during the boating season. Over 70% of these boats are longer than 21 feet (Table 12).

The estimated distribution of boats in different size and different types of storage in (storage) regions is shown in Table 13. Based on the survey, about half of Michigan boats are stored in the south-inland and southeast regions. A high proportion of marina boats are stored in the southeast region. The north-inland, northeast and northwest regions are popular storage locations for boats stored at second homes. A high percentage of boats under 20 feet stored at waterfront homes are kept in the south-inland region. The southeast region hosts a greater percentage (39%) of larger boats stored at waterfront homes. Most boats stored at nonwaterfront homes are kept in south-inland and southeast regions where most of Michigan's population resides.

Measures of a county's boat storage opportunities (capacities) are used to allocate boats to the counties within each region where they are kept. The number of marina spaces in each county is used as an indicator (GM indicator) of a county's storage opportunities for marina boats kept in the coastal counties[18]. The "number of lakes over 50 acres" and "total acres of inland lakes in the county" are combined into an storage opportunity index (LM index) to allocate marina boats to inland counties[19]. The number

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[18] The number of marina spaces in the coastal counties was collected by the 1994 Great Lakes Marina Census.

[19] An index of inland county's boat-storage opportunity for marina boats is constructed as following:

$$\text{GM index} = \text{no of lakes over 50 acres} * \frac{\text{acres of lakes in the county}}{\text{state average acres of lakes}}$$

The information on the number of lakes over 50 acres and total acres of inland lakes was collected in "Michigan Lakes Inventory" (Michigan Department of Natural Resources, 1974).

Table 12. Estimated Number of Boats in Storage Segments by Size Classes.

Storage Segments	Boat Size	No. of Boats[a]	Percent	Unweighted Cases
Marina Segment		*59,077*	*11.6%*	*984*
	20 feet or smaller	16,105	3.2%	66
	21-28 feet	27,354	5.4%	244
	29 feet or larger	15,618	3.1%	674
Second Home Segment		*134,072*	*26.3%*	*574*
	Less than 16 feet	73,153	14.4%	127
	16-20 feet	39,325	7.7%	218
	21 feet or larger	21,594	4.2%	229
Waterfront Home Segment		*119,187*	*23.4%*	*593*
	Less than 16 feet	50,331	9.9%	104
	16-20 feet	38,941	7.7%	193
	21 feet or larger	29,915	5.9%	296
Nonwaterfront Home Segment		*196,686*	*38.6%*	*603*
	Less than 16 feet	135,386	26.6%	264
	16 feet or larger	61,300	12.0%	339
Total		*509,022*	*100.0%*	*2,754*

a. Cases with missing storage type and/or storage county information are excluded from the analysis.

note: Estimates are based on the 1994 Michigan Boating Survey.

Table 13. Number and Percentage of Boats in Different Storage Segments by Region Where Boat Is Kept During Boating Season.

	BOAT STORAGE SEGMENTS											All Boats
	Marina			Second Home			Waterfront Home			Nonwaterfront Home		
Storage Region	20' or less	21'-28'	29' or larger	<16'	16'-20'	21' or larger	<16'	16'-20'	21' or larger	<16'	16' or larger	
Number of boats												
Southeast	5,538	11,785	8,321	694	1,089	2,189	4,162	5,035	11,635	16,807	13,726	80,981
East Central	1,566	3,579	1,182	3,641	1,136	545	1,040	103	530	7,801	4,398	25,521
Northeast	704	1,500	709	8,700	5,537	2,599	2,854	1,701	962	4,144	2,120	31,530
Northwest	2,661	3,130	1,435	10,302	7,356	2,674	5,596	3,041	1,952	7,869	3,740	49,756
West Central	220	2,664	1,784	3,137	659	1,124	476	659	1,486	8,153	5,811	26,173
Southwest	243	1,203	1,368	1,016	1,661	726	3,531	1,243	1,435	7,027	2,305	21,758
South Inland	3,268	1,680	39	14,395	8,284	3,680	18,810	22,025	8,139	65,666	22,711	168,697
North Inland	497	723	274	21,948	7,246	4,263	6,442	3,814	2,886	13,358	3,744	65,195
South UP	0	482	267	6,839	3,893	3,090	2,572	455	534	2,495	1,261	21,888
North UP	1,406	609	239	2,480	2,463	704	4,847	865	355	2,068	1,484	17,520
Total	16,103	27,355	15,618	73,152	39,324	21,594	50,330	38,941	29,914	135,388	61,300	509,019
Percent of boats												
Southeast	34%	43%	53%	1%	3%	10%	8%	13%	39%	12%	22%	16%
East Central	10%	13%	8%	5%	3%	3%	2%	0%	2%	6%	7%	5%
Northeast	4%	5%	5%	12%	14%	12%	6%	4%	3%	3%	3%	6%
Northwest	17%	11%	9%	14%	19%	12%	11%	8%	7%	6%	6%	10%
West Central	1%	10%	11%	4%	2%	5%	1%	2%	5%	6%	9%	5%
Southwest	2%	4%	9%	1%	4%	3%	7%	3%	5%	5%	4%	4%
South Inland	20%	6%	0%	20%	21%	17%	37%	57%	27%	49%	37%	33%
North Inland	3%	3%	2%	30%	18%	20%	13%	10%	10%	10%	6%	13%
South UP	NA	2%	2%	9%	10%	14%	5%	1%	2%	2%	2%	4%
North UP	9%	2%	2%	3%	6%	3%	10%	2%	1%	2%	2%	3%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

note 1: Cases with missing storage type and/or storage county information are excluded from the analysis.

note 2: Estimates are based on the 1994 Michigan Boating Survey.

of second homes in each county is used as an indicator (SH indicator) of second home opportunities[20]. The number of registered boats by size class used as an indicator (RS indicators) for boats kept at waterfront homes and nonwaterfront homes[21]. Indices for all counties are provided in Appendix C.

The indicators (index) measure a county's attractiveness as a potential storage location for boats in different storage segments. The indices are used to distribute boats to counties in each region for each storage type. The following county level allocation formula is used:

$$T_{(i|r)} = \frac{S_i}{\sum_{i \in \text{Region } r} S_i}$$

where $T_{(i|r)}$: total number of boats kept in county i, given region r; and
S_i : the availability of storage opportunities in county i.
S_i = Number of marina spaces in the county for marina boats kept in coastal counties.
S_i = The value of IM index (number of lakes over 50 acres and total acres of inland lakes) in the county for marina boats kept in inland counties.
S_i = Number of second homes in the county for boats stored at second homes.
S_i = Number of registered boats in the county for different sized boats stored at waterfront homes and nonwaterfront homes.
note - formula allocates a share to each county within the region in proportion to its share of regional opportunities.

Assumptions

The allocation models make five basic assumptions in order to estimate the number of boats in different types of storage kept in counties.

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[20] The number of second homes in counties comes from 1990 Michigan Census.
[21] The number of registered boats by different size classes in counties is part of the Michigan Boat Registration Database (Michigan Secretary of State, 1994).

(1) The estimates of the regional distribution of boats in storage segments by size classes from 1994 Michigan Boating Survey are reliable.

(2) It is assumed that county level marina occupancy rates do not vary significantly within a given region. The number of marina spaces reflects the distribution of marina boats in coastal regions.

(3) The boat-storage opportunity index based on number of inland lakes over 50 acre and acres of inland lakes reflects the number of boats stored at marinas in the inland counties.

(4) The propensity of second homes to provide storage for boats is similar across counties within a given region. In other words, the distribution of second homes will mirror the distribution of boats stored at second homes within a region.

(5) The distribution of registered boats within different size classes reflects the distribution of boats stored at waterfront and nonwaterfront permanent residences in a given region.

Results

The predictions of the allocation models are reported in Table 14. The total number of boats kept in Michigan counties ranges from 700 boats in Keweenaw county to 34,000 boats in Oakland county. Southeast counties house the largest number of boats. The fewest number of boats are kept in northern Upper Peninsula counties. The number of boats kept in counties varies within a region. For example, in the southeast region, Wayne county houses almost four times the number of boats kept in Monroe county.

Table 14. Number and Percentage of Boats in Michigan Counties by Storage Segments.

Storage County	BOAT STORAGE SEGMENTS												Total	
	Marina			Second Home			Waterfront Home			Nonwaterfront Home				
	No. of Boats	Col %	Row %	No. of Boats	Col %	Row %	No. of Boats	Col %	Row %	No. of Boats	Col %	Row %	No. of Boats	Col %
Macomb	9,558	16.18%	35%	556	0.41%	2%	7,317	6.14%	27%	9,875	5.02%	36%	27,306	5.36%
Monroe	4,920	8.33%	56%	308	0.23%	3%	1,417	1.19%	16%	2,170	1.10%	25%	8,816	1.73%
St Clair	4,882	8.26%	41%	2,028	1.51%	17%	2,005	1.68%	17%	2,932	1.49%	25%	11,847	2.33%
Wayne	6,284	10.64%	19%	1,080	0.81%	3%	10,092	8.47%	31%	15,556	7.91%	47%	33,012	6.49%
Southeast	***25,644***	***43.41%***	***32%***	***3,972***	***2.96%***	***5%***	***20,832***	***17.48%***	***26%***	***30,533***	***15.52%***	***38%***	***80,981***	***15.91%***
Bay	3,594	6.08%	47%	177	0.13%	2%	479	0.40%	6%	3,356	1.71%	44%	7,606	1.49%
Huron	1,732	2.93%	31%	2,755	2.06%	49%	144	0.12%	3%	1,015	0.52%	18%	5,646	1.11%
Saginaw	112	0.19%	2%	109	0.08%	2%	748	0.63%	11%	5,591	2.84%	85%	6,560	1.29%
Sanilac	448	0.76%	14%	1,880	1.40%	60%	97	0.08%	3%	717	0.36%	23%	3,142	0.62%
Tuscola	440	0.74%	17%	401	0.30%	16%	205	0.17%	8%	1,520	0.77%	59%	2,567	0.50%
Central East	***6,327***	***10.71%***	***25%***	***5,322***	***3.97%***	***21%***	***1,673***	***1.40%***	***7%***	***12,199***	***6.20%***	***48%***	***25,521***	***5.01%***
Alcona	96	0.16%	2%	3,876	2.89%	75%	566	0.47%	11%	644	0.33%	12%	5,183	1.02%
Alpena	221	0.37%	6%	1,252	0.93%	33%	1,049	0.88%	28%	1,262	0.64%	33%	3,784	0.74%
Arenac	693	1.17%	17%	1,669	1.24%	41%	852	0.72%	21%	845	0.43%	21%	4,059	0.80%
Cheboygan	695	1.18%	11%	3,341	2.49%	51%	1,173	0.98%	18%	1,327	0.67%	20%	6,536	1.28%
Iosco	968	1.64%	12%	4,594	3.43%	56%	1,233	1.03%	15%	1,423	0.72%	17%	8,218	1.61%
Presque Isle	240	0.41%	6%	2,105	1.57%	56%	643	0.54%	17%	763	0.39%	20%	3,751	0.74%
Northeast	***2,913***	***4.93%***	***9%***	***16,836***	***12.56%***	***53%***	***5,517***	***4.63%***	***17%***	***6,264***	***3.18%***	***20%***	***31,530***	***6.19%***
Antrim	240	0.41%	4%	3,203	2.39%	53%	1,239	1.04%	21%	1,354	0.69%	22%	6,035	1.19%
Benzie	796	1.35%	17%	2,145	1.60%	45%	861	0.72%	18%	982	0.50%	21%	4,785	0.94%
Charlevoix	1,963	3.32%	29%	2,642	1.97%	38%	1,102	0.92%	16%	1,165	0.59%	17%	6,872	1.35%
Emmet	768	1.30%	12%	2,989	2.23%	48%	1,212	1.02%	19%	1,313	0.67%	21%	6,282	1.23%
Grand Traverse	384	0.65%	4%	2,248	1.68%	25%	3,083	2.59%	34%	3,317	1.69%	37%	9,032	1.77%
Leelanau	1,069	1.81%	17%	2,846	2.12%	44%	1,201	1.01%	19%	1,305	0.66%	20%	6,421	1.26%
Manistee	1,248	2.11%	23%	2,180	1.63%	41%	884	0.74%	17%	1,011	0.51%	19%	5,323	1.05%
Mason	758	1.28%	15%	2,077	1.55%	41%	1,008	0.85%	20%	1,162	0.59%	23%	5,006	0.98%
Northwest	***7,226***	***12.23%***	***15%***	***20,332***	***15.17%***	***41%***	***10,589***	***8.88%***	***21%***	***11,609***	***5.90%***	***23%***	***49,756***	***9.77%***
Muskegon	1,664	2.82%	19%	899	0.67%	10%	967	0.81%	11%	5,321	2.71%	60%	8,851	1.74%
Oceana	118	0.20%	3%	2,693	2.01%	68%	147	0.12%	4%	988	0.50%	25%	3,946	0.78%
Ottawa	2,886	4.89%	22%	1,328	0.99%	10%	1,507	1.26%	11%	7,655	3.89%	57%	13,376	2.63%
West Central	***4,668***	***7.90%***	***18%***	***4,920***	***3.67%***	***19%***	***2,621***	***2.20%***	***10%***	***13,964***	***7.10%***	***53%***	***26,173***	***5.14%***
Allegan	640	1.08%	10%	869	0.65%	13%	1,977	1.66%	30%	3,007	1.53%	46%	6,493	1.28%
Berrien	1,578	2.67%	16%	1,416	1.06%	15%	2,689	2.26%	28%	3,963	2.02%	41%	9,646	1.90%
Van Buren	596	1.01%	11%	1,118	0.83%	20%	1,543	1.29%	27%	2,362	1.20%	42%	5,618	1.10%
Southwest	***2,814***	***4.76%***	***13%***	***3,403***	***2.54%***	***16%***	***6,209***	***5.21%***	***29%***	***9,332***	***4.74%***	***43%***	***21,758***	***4.27%***

Table 14 (cont'd).

Storage County	BOAT STORAGE SEGMENTS												Total	
	Marina			Second Home			Waterfront Home			Nonwaterfront Home				
	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %
Barry	307	0.52%	5%	2,057	1.53%	36%	1,142	0.96%	20%	2,232	1.13%	39%	5,738	1.13%
Branch	246	0.42%	5%	2,319	1.73%	46%	874	0.73%	17%	1,650	0.84%	32%	5,088	1.00%
Calhoun	100	0.17%	2%	9	0.01%	0%	1,444	1.21%	32%	3,010	1.53%	66%	4,563	0.90%
Cass	375	0.64%	6%	2,827	2.11%	43%	1,164	0.98%	18%	2,205	1.12%	34%	6,571	1.29%
Clinton	2	0.00%	0%	41	0.03%	2%	827	0.69%	33%	1,625	0.83%	65%	2,495	0.49%
Eaton	2	0.00%	0%	132	0.10%	4%	1,150	0.97%	33%	2,241	1.14%	64%	3,525	0.69%
Genesee	56	0.10%	0%	708	0.53%	5%	4,566	3.83%	34%	8,201	4.17%	61%	13,531	2.66%
Gratiot	7	0.01%	0%	95	0.07%	6%	464	0.39%	31%	938	0.48%	62%	1,504	0.30%
Hillsdale	56	0.10%	2%	1,628	1.21%	46%	662	0.56%	19%	1,215	0.62%	34%	3,562	0.70%
Ingham	1	0.00%	0%	311	0.23%	4%	2,331	1.96%	33%	4,471	2.27%	63%	7,113	1.40%
Ionia	13	0.02%	1%	350	0.26%	15%	662	0.56%	28%	1,365	0.69%	57%	2,390	0.47%
Isabella	9	0.01%	0%	838	0.62%	33%	569	0.48%	22%	1,121	0.57%	44%	2,536	0.50%
Jackson	346	0.59%	4%	1,655	1.23%	20%	2,154	1.81%	26%	4,025	2.05%	49%	8,181	1.61%
Kalamazoo	263	0.44%	3%	551	0.41%	7%	2,623	2.20%	31%	4,995	2.54%	59%	8,472	1.66%
Kent	235	0.40%	1%	1,222	0.91%	7%	5,979	5.02%	32%	11,253	5.72%	60%	18,689	3.67%
Lapeer	60	0.10%	2%	667	0.50%	20%	903	0.76%	28%	1,654	0.84%	50%	3,284	0.65%
Lenawee	76	0.13%	1%	1,954	1.46%	36%	1,213	1.02%	22%	2,215	1.13%	41%	5,458	1.07%
Livingston	456	0.77%	6%	1,475	1.10%	19%	2,196	1.84%	28%	3,604	1.83%	47%	7,731	1.52%
Midland	14	0.02%	0%	374	0.28%	9%	1,282	1.08%	32%	2,358	1.20%	59%	4,028	0.79%
Montcalm	173	0.29%	3%	2,577	1.92%	48%	854	0.72%	16%	1,815	0.92%	33%	5,418	1.06%
Oakland	1,636	2.77%	5%	2,295	1.71%	7%	11,736	9.85%	34%	18,450	9.38%	54%	34,117	6.70%
St Joseph	299	0.51%	6%	1,329	0.99%	26%	1,142	0.96%	23%	2,276	1.16%	45%	5,047	0.99%
Shiawassee	4	0.01%	0%	105	0.08%	4%	816	0.68%	32%	1,611	0.82%	64%	2,535	0.50%
Washtenaw	250	0.42%	3%	839	0.63%	12%	2,220	1.86%	31%	3,849	1.96%	54%	7,159	1.41%
South Inland	***4,987***	***8.44%***	***3%***	***26,359***	***19.66%***	***16%***	***48,974***	***41.09%***	***29%***	***88,377***	***44.93%***	***52%***	***168,697***	***33.14%***
Clare	78	0.13%	1%	3,735	2.79%	59%	1,047	0.88%	17%	1,452	0.74%	23%	6,312	1.24%
Crawford	18	0.03%	1%	1,764	1.32%	55%	681	0.57%	21%	766	0.39%	24%	3,228	0.63%
Gladwin	63	0.11%	1%	2,476	1.85%	48%	1,201	1.01%	23%	1,411	0.72%	27%	5,151	1.01%
Kalkaska	54	0.09%	2%	1,563	1.17%	50%	632	0.53%	20%	862	0.44%	28%	3,111	0.61%
Lake	30	0.05%	1%	3,364	2.51%	74%	501	0.42%	11%	652	0.33%	14%	4,546	0.89%
Mecosta	158	0.27%	4%	1,476	1.10%	34%	1,156	0.97%	27%	1,532	0.78%	35%	4,322	0.85%
Missaukee	37	0.06%	2%	1,088	0.81%	47%	509	0.43%	22%	672	0.34%	29%	2,305	0.45%
Montmorency	164	0.28%	4%	2,197	1.64%	60%	521	0.44%	14%	771	0.39%	21%	3,653	0.72%
Newaygo	176	0.30%	3%	2,280	1.70%	37%	1,560	1.31%	25%	2,121	1.08%	35%	6,137	1.21%
Ogemaw	76	0.13%	2%	2,560	1.91%	56%	811	0.68%	18%	1,087	0.55%	24%	4,534	0.89%

Table 14 (cont'd).

Storage County	BOAT STORAGE SEGMENTS: Marina			Second Home			Waterfront Home			Nonwaterfront Home			Total	
	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %	Row %	No. of Boats	Col. %
Osceola	16	0.03%	1%	1,500	1.12%	51%	565	0.47%	19%	862	0.44%	29%	2,944	0.58%
Oscoda	19	0.03%	1%	2,038	1.52%	66%	444	0.37%	14%	565	0.29%	18%	3,066	0.60%
Otsego	91	0.15%	3%	1,673	1.25%	48%	715	0.60%	21%	1,000	0.51%	29%	3,478	0.68%
Roscommon	472	0.80%	5%	4,770	3.56%	54%	1,715	1.44%	19%	1,922	0.98%	22%	8,878	1.74%
Wexford	42	0.07%	1%	976	0.73%	28%	1,084	0.91%	31%	1,427	0.73%	40%	3,529	0.69%
North Inland	***1,494***	***2.53%***	***2%***	***33,457***	***24.95%***	***51%***	***13,142***	***11.03%***	***20%***	***17,102***	***8.69%***	***26%***	***65,195***	***12.81%***
Delta	179	0.30%	4%	2,342	1.75%	53%	908	0.76%	21%	976	0.50%	22%	4,406	0.87%
Dickinson	0	0.00%	0%	1,640	1.22%	55%	658	0.55%	22%	709	0.36%	24%	3,008	0.59%
Iron	0	0.00%	0%	2,509	1.87%	71%	493	0.41%	14%	514	0.26%	15%	3,516	0.69%
Mackinac	366	0.62%	7%	3,922	2.93%	71%	606	0.51%	11%	618	0.31%	11%	5,512	1.08%
Menominee	173	0.29%	6%	1,677	1.25%	58%	517	0.43%	18%	545	0.28%	19%	2,912	0.57%
Schoolcraft	31	0.05%	1%	1,731	1.29%	68%	378	0.32%	15%	394	0.20%	16%	2,534	0.50%
South Upper Peninsula	***749***	***1.27%***	***3%***	***13,822***	***10.31%***	***63%***	***3,561***	***2.99%***	***16%***	***3,756***	***1.91%***	***17%***	***21,888***	***4.30%***
Alger	60	0.10%	5%	514	0.38%	41%	436	0.37%	35%	246	0.13%	20%	1,255	0.25%
Baraga	326	0.55%	31%	316	0.24%	30%	249	0.21%	24%	147	0.07%	14%	1,038	0.20%
Chippewa	883	1.49%	21%	1,323	0.99%	32%	1,190	1.00%	29%	729	0.37%	18%	4,124	0.81%
Gogebic	82	0.14%	4%	699	0.52%	38%	681	0.57%	37%	382	0.19%	21%	1,844	0.36%
Houghton	314	0.53%	14%	668	0.50%	29%	803	0.67%	35%	495	0.25%	22%	2,280	0.45%
Keweenaw	172	0.29%	26%	355	0.26%	53%	85	0.07%	13%	53	0.03%	8%	665	0.13%
Luce	0	0.00%	0%	307	0.23%	36%	364	0.31%	42%	193	0.10%	22%	864	0.17%
Marquette	332	0.56%	7%	1,127	0.84%	25%	1,926	1.62%	43%	1,122	0.57%	25%	4,508	0.89%
Ontonagon	84	0.14%	9%	338	0.25%	36%	334	0.28%	35%	186	0.09%	20%	942	0.18%
North Upper Peninsula	***2,254***	***3.82%***	***13%***	***5,647***	***4.21%***	***32%***	***6,067***	***5.09%***	***35%***	***3,552***	***1.81%***	***20%***	***17,520***	***3.44%***
STATE TOTAL	**59,076**	**100%**	**12%**	**134,070**	**100%**	**26%**	**119,185**	**100%**	**23%**	**196,688**	**100%**	**39%**	**509,019**	**100%**

note: the total number of boats is less than the number of registered active recreational watercraft (555,000 boats), due to the cases with missing storage variables are excluded from the (survey based) estimates of boats in different storage segments by storage regions (Table 13) which are used to allocate boats to storage regions in the allocation models

Counties where boats are kept vary across storage segments. Over forty percent of marina boats are kept in southeast Michigan. Sixteen percent of boats stored at marinas are in Macomb county. The number of boats stored at marinas is different across counties within a region. In the northwest region, only 240 boats are stored at marinas in Antrim county, while almost 2,000 boats are stored at marinas in neighboring Charlevoix county.

About a third of boats stored at second homes are kept in northern inland or southern Upper Peninsula counties. The fewest numbers of boats stored at second homes are in southeast and southwest counties. Roscommon and Mackinac counties have the largest number of boats stored at second homes.

There are more waterfront homes in counties with water resources and large populations and as a result more boats stored at waterfront homes in these counties. Almost 60% of all boats stored at permanent waterfront homes are in southeast or south inland counties. About a quarter of all boats kept at waterfront homes are in Wayne, Oakland and Macomb counties.

Over 60% of boats at nonwaterfront homes are kept in southeast or south-inland counties. Oakland, Wayne and Kent counties house more boats at nonwaterfront homes than any of the other counties. In large part, this is a function of their population sizes. For example, there are 2.75 times more boats stored at nonwaterfront homes in Ingham county than neighboring Clinton county. Ingham has more population.

It is also useful to examine the ratio of boats kept in regions to the number of boats originating from regions (Table 15). The locations where boat owners reside are the places from which the boats originate. Ratio values greater than one indicate that the

Table 15. Number of Boats by Region of Residence, Region of Storage and Storage Type.

	BOAT STORAGE SEGMENTS				
	Marina	Second Home	Waterfront Home	Nonwaterfront Home	Total
Residence Regions					
Southeast	17,088	23,352	19,417	30,862	90,719
East Central	3,986	7,478	1,885	12,317	25,666
Northeast	1,122	1,813	5,459	6,113	14,507
Northwest	2,942	2,468	10,663	11,396	27,469
Central West	2,703	3,527	2,608	13,637	22,475
Southwest	1,741	3,019	6,460	9,309	20,529
Inland South	21,891	58,233	49,182	88,780	218,086
Inland North	1,218	3,925	12,541	16,365	34,049
Up South	413	4,121	3,557	3,755	11,846
UP North	1,627	1,072	6,103	3,551	12,353
State Total	54,731	109,008	117,875	196,085	477,699
Out of state	3,745	24,105			27,850
Missing	600	957	1,310	603	3,470
Total	59,076	134,070	119,185	196,688	509,019
Storage Regions					
Southeast	25,644	3,972	20,832	30,533	80,981
East Central	6,327	5,322	1,673	12,199	25,521
Northeast	2,913	16,836	5,517	6,264	31,530
Northwest	7,226	20,332	10,589	11,609	49,756
Central West	4,668	4,920	2,621	13,964	26,173
Southwest	2,814	3,403	6,209	9,332	21,758
South Inland	4,987	26,359	48,974	88,377	168,697
North Inland	1,494	33,457	13,142	17,102	65,195
South UP	749	13,822	3,561	3,756	21,888
North UP	2,254	5,647	6,067	3,552	17,520
State Total	59,076	134,070	119,185	196,688	509,019
Ratio of Number of Boats in Storage Regions to Number of Boats in Residence Regions					
Southeast	1.50	0.17	1.07	0.99	0.89 [a]
East Central	1.59	0.71	0.89	0.99	0.99
Northeast	2.60	9.29	1.01	1.02	2.17
Northwest	2.46	8.24	0.99	1.02	1.81
Central West	1.73	1.39	1.00	1.02	1.16
Southwest	1.62	1.13	0.96	1.00	1.06
South Inland	0.23	0.45	1.00	1.00	0.77
North Inland	1.23	8.52	1.05	1.05	1.91
South UP	1.81	3.35	1.00	1.00	1.85
North UP	1.39	5.27	0.99	1.00	1.42
State Total	1.08	1.23	1.01	1.00	1.07

a. The ratio, 0.89, is equal to the number of boats in southeast (storage) region, 80,981, divided by the number of boats in southeast (residence) region, 90,719.

note: Number of boats in residence regions is estimated from the 1994 Michigan Boating survey.

region is a net importer of boats, while counties with ratios less than one are net exporters. The southeast, east-central and south-inland regions are net exporting regions. Other regions are net importing regions, especially the northeast, northwest, north-inland and south Upper Peninsula regions. The net flows capture the south-to-north boating travel patterns.

The south-inland region is a "net exporting" region of boats stored at marinas and second homes. Northern Michigan regions are "net importing" regions. The general south-north travel patterns apply for these storage segments, except that the southeast region is a "net importing" region for boats at marinas and "net exporting" region for boats stored at second homes. The south-to-north patterns are much more obvious for boats stored at second homes. For example, the number of boats stored at second homes in the northeast region is nine times the number of boats stored at second homes originating in the region. For the boats stored at marinas in the northeast region, the ratio is only 2.6.

Model Evaluation

The allocation models are evaluated on the bases of both regional level estimates and county level estimates. The two estimates are evaluated separately. The percent of boats in different size classes and types of storage that are kept in regions is estimated from the 1994 Michigan Boating Survey. The model uses these estimates to allocate boats to the regions where they are kept. Sampling errors are calculated for the estimated distribution. The sampling errors indicate the range of accuracy for regional level

estimates. County level estimates are evaluated by comparing the allocation model estimates to direct survey estimates.

Table 16 provides estimated sampling errors at a 95 percent confidence level[22] for the estimated distribution of boats by storage segment and size class in the regions. For example, based on the 1994 Michigan Boating Survey, it is estimated that 15.9% of all registered boats are kept in the southeast region. The sampling error for this estimate is 1.3% (absolute percent) at a 95% confidence level. Therefore, the 95% confidence interval for the percent of all registered boats kept in the southeast region is between 14.6% and 17.2%.

All sampling errors for the estimated distributions are under 10%; the majority (90%) of the sampling errors are under 5%. The largest sampling errors occur for the small boat size classes[23] - boats under 20 feet stored at marinas, boats less than 16 feet stored at second homes, and boats less than 16 feet stored at waterfront homes. The estimated distribution for boats under 20 feet stored at marinas is less reliable, due to the large sampling errors ranging from 3% to 10%. For example, based on survey estimates, 34% of boats (5,500 boats) under twenty feet stored at marinas are kept in the southeast region. With 9% sampling error at the 95 percent confidence level, the number of boats

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[22] The sampling error at 95 percent confidence interval for binomial distribution is formulated as:

$$e^2 = \frac{Z^2[P^*(1-P)]}{N}$$

Where e= error
Z=1.96 at the 95 percent confidence level
P= population proportion
N= number of cases

[23] The 1994 Michigan Boating Survey sampled fewer small size boats.

Table 16. Regional Distribution of Boats by Storage Segment: Sampling Errors at A 95% Confidence Interval.

	BOAT STORAGE SEGMENTS											
	Marina			Second Home			Waterfront Home			Nonwaterfront Home		All Boats
Storage Regions	20' or less	21'-28'	29' or larger	<16'	16'-20'	21' or larger	<16'	16'-20'	21' or larger	<16'	16' or larger	
Sampling Error at 95% Confidence Interval												
Southeast	9.0%	5.1%	3.1%	1.5%	1.8%	3.0%	4.5%	3.1%	4.8%	3.5%	3.2%	1.3% [a]
East Central	7.9%	4.3%	2.6%	3.7%	2.0%	1.9%	2.6%	1.0%	2.0%	2.8%	2.8%	1.0%
Northeast	6.4%	3.7%	2.3%	5.4%	4.6%	4.0%	5.4%	3.9%	3.2%	2.4%	2.4%	1.1%
Northwest	10.3%	5.1%	2.9%	6.1%	5.3%	5.3%	6.8%	4.9%	4.2%	3.2%	3.2%	1.4%
Central West	2.9%	3.8%	2.6%	3.7%	1.5%	3.0%	1.9%	1.7%	3.0%	3.0%	3.0%	1.0%
Southwest	2.9%	2.5%	2.5%	2.2%	2.8%	2.2%	4.8%	2.4%	2.0%	2.6%	1.9%	0.9%
South Inland	8.7%	1.8%	0.5%	6.7%	5.0%	3.4%	9.0%	7.0%	3.8%	6.0%	4.8%	1.4%
North Inland	5.0%	1.8%	1.1%	8.1%	4.9%	4.4%	6.9%	5.0%	3.7%	4.1%	3.1%	1.1%
South UP	NA	2.8%	1.4%	4.9%	4.4%	5.4%	4.1%	3.1%	2.9%	1.5%	2.9%	1.0%
North UP	9.0%	3.9%	1.6%	3.4%	4.1%	3.4%	5.4%	3.3%	2.7%	1.5%	3.0%	0.9%
Distribution of boats in regions												
Southeast	34.4%	43.1%	53.3%	0.9%	2.8%	10.1%	8.3%	12.9%	38.9%	12.4%	22.4%	15.9% [a]
East Central	9.7%	13.1%	7.6%	5.0%	2.9%	2.5%	2.1%	0.3%	1.8%	5.8%	7.2%	5.0%
Northeast	4.4%	5.5%	4.5%	11.9%	14.1%	12.0%	5.7%	4.4%	3.2%	3.1%	3.5%	6.2%
Northwest	16.5%	11.4%	9.2%	14.1%	18.7%	12.4%	11.1%	7.8%	6.5%	5.8%	6.1%	9.8%
Central West	1.4%	9.7%	11.4%	4.3%	1.7%	5.2%	0.9%	1.7%	5.0%	6.0%	9.5%	5.1%
Southwest	1.5%	4.4%	8.8%	1.4%	4.2%	3.4%	7.0%	3.2%	4.8%	5.2%	3.8%	4.3%
South Inland	20.3%	6.1%	0.2%	19.7%	21.1%	17.0%	37.4%	56.6%	27.2%	48.5%	37.0%	33.1%
North Inland	3.1%	2.6%	1.8%	30.0%	18.4%	19.7%	12.8%	9.8%	9.6%	9.9%	6.1%	12.8%
South UP	NA	1.8%	1.7%	9.3%	9.9%	14.3%	5.1%	1.2%	1.8%	1.8%	2.1%	4.3%
North UP	8.7%	2.2%	1.5%	3.4%	6.3%	3.3%	9.6%	2.2%	1.2%	1.5%	2.4%	3.4%
No. of Boats	*16,103*	*27,355*	*15,618*	*73,152*	*39,324*	*21,594*	*50,330*	*38,941*	*29,914*	*135,388*	*61,300*	*509,019*
No of Samples	*66*	*244*	*674*	*127*	*218*	*229*	*104*	*193*	*296*	*264*	*339*	*2754*

a. With a 95% of confidence interval, the sampling error is 1.3% for boats kept in southeast region which represent 16% of boats in the state. Therefore, the "population" percentage of boats in the southeast region is between (16%-1.3%) and (16%+1.3%).

under twenty feet stored at marinas in southeast region could range anywhere from 4,000 boats to 6,900 boats (25% to 43%).

The allocation model is also evaluated on estimates of the number of boats kept in counties. Model estimates are compared with the direct estimates from the 1994 Michigan Boating Survey. Errors in model estimates are likely the result of using county boat-storage opportunity indicators/index to allocate boats to counties within the region where the boats are kept. The survey-based estimates are subject to sampling errors. Large sampling error are usually associated with county level estimates due to small sample sizes. Fifty one of 83 counties have sample sizes of less than 30 boats; only 32 counties have sample sizes of more than 30 boats. Sample sizes are much smaller for individual storage segments at the county level.

The percent difference is computed as the difference between model estimates and direct survey estimates in proportion to the survey estimate. The percent differences ranges from a low of 1% for Roscommon county to a high of 799% for Luce county. Only one boat was sampled in Luce county, so the survey-based estimate is quite unreliable. Most counties with greater than 100% percent difference have sample sizes of less than 10 boats. The 32 counties with samples of 30 or more boats provide a more valid basis for evaluating the allocation models (Table 17). For those 32 counties, the percent difference range from 1% for Roscommon county to 51% for Mackinac county. For eleven counties the percent difference is 10% or less. The percent difference is more than 30 % for five counties.

The percent difference only indicates discrepancy between model estimates and direct survey estimates. It does not indicate which estimate is more accurate. For

Table 17. Number of Boats Stored in Counties: A Comparison of Survey Estimates and Allocation Model Estimates.

	Allocation Model	Survey Results[a]		Difference[b]					Percent Difference[c]
				Marina	Second Home	Waterfront Home	Nonwaterfront Home	All Segments	
Counties With Sample Sizes More Than 30 Boats									
Allegan	6.493	7.832	(52)	-313	-656	-1833	1463	-1339	-17%
Alpena	3.784	3.565	(31)	87	44	-304	392	219	6%
Antrim	6.035	7.924	(49)	-1186	-590	-880	768	-1889	-24%
Arenac	4.059	3.699	(33)	-391	535	530	-314	360	10%
Bay	7.606	7.389	(117)	-324	164	50	327	217	3%
Berrien	9.646	8.726	(64)	591	634	987	-1292	920	11%
Charlevoix	6.872	7.194	(75)	937	-1525	248	18	-322	-4%
Cheboygan	6.536	7.857	(91)	-473	-907	-253	312	-1321	-17%
Chippewa	4.124	5.263	(34)	622	-2222	-44	506	-1139	-22%
Delta	4.406	4.194	(44)	6	1425	-569	-651	212	5%
Emmet	6.282	4.821	(73)	-596	1784	781	-508	1461	30%
Genesee	13.531	9.304	(37)	-260	244	2619	1624	4227	45%
Grand Traverse	9.032	8.489	(72)	-136	164	-183	698	543	6%
Houghton	2.280	2.675	(37)	-69	528	-601	-253	-395	-15%
Iosco	8.218	7.343	(49)	546	243	77	9	875	12%
Jackson	8.181	12.347	(33)	-427	-628	-874	-2238	-4166	-34%
Kalamazoo	8.432	11.829	(36)	-163	-1106	-501	-1627	-3397	-29%
Kent	18.689	15.565	(50)	235	-44	3632	-699	3124	20%
Leelanau	6.421	7.253	(80)	-141	131	-1040	218	-832	-11%
Mackinac	5.512	11.156	(97)	-123	-5006	-1126	611	-5644	-51%
Macomb	27.306	24.904	(116)	2472	-193	-1878	2001	2402	10%
Manistee	5.323	5.957	(52)	-102	1967	72	-2571	-634	-11%
Marquette	4.508	5.111	(57)	-283	99	-99	-321	-603	-12%
Monroe	8.816	9.479	(45)	1332	308	423	-2727	-663	-7%
Muskegon	8.851	9.225	(91)	-938	-551	-292	1407	-374	-4%
Newaygo	6.137	10.151	(37)	-91	-3365	-336	-222	-4014	-40%
Oakland	34.117	27.342	(54)	-568	694	158	6491	6775	25%
Ottawa	13.376	14.346	(116)	846	21	339	-2176	-970	-7%
Roscommon	8.878	8.925	(51)	-282	561	-1146	821	-47	-1%
St Clair	11.847	16.325	(85)	-933	-501	-3268	224	-4478	-27%
Van Buren	5.618	5.201	(41)	-278	21	846	-171	417	8%
Wayne	33.012	30.273	(124)	-2871	386	4722	502	2739	9%

Table 17 (cont'd).

	Allocation Model	Survey Results[a]		Difference[b]					Percent Difference[c]
				Marina	Second Home	Waterfront Home	Nonwaterfront Home	All Segments	
Counties With Sample Sizes Less Than 30 Boats									
Alcona	5,183	5,491	(22)	72	-186	-9	-186	-308	-6%
Alger	1,255	2,141	(13)	-530	319	-787	113	-886	-41%
Baraga	1,038	445	(13)	61	256	189	87	593	133%
Barry	5,738	8,246	(28)	-156	-66	-2166	-120	-2508	-30%
Benzie	4,785	4,503	(25)	552	-1347	488	588	282	6%
Branch	5,088	4,095	(14)	246	1668	-1489	569	993	24%
Calhoun	4,563	4,514	(10)	100	-775	1201	-477	49	1%
Cass	6,571	6,893	(26)	-317	975	-2644	1664	-322	-5%
Clare	6,312	5,333	(18)	78	952	303	-354	979	18%
Clinton	2,495	2,954	(10)	2	41	-44	-458	-459	-16%
Crawford	3,228	3,454	(15)	18	121	282	-646	-226	-7%
Dickinson	3,008	1,520	(10)	0	471	577	439	1488	98%
Eaton	3,525	2,122	(6)	2	132	366	903	1403	66%
Gladwin	5,151	5,536	(22)	63	-1561	493	620	-385	-7%
Gogebic	1,844	703	(15)	-4	352	681	112	1141	162%
Gratiot	1,504	2,813	(6)	7	95	-56	-1355	-1309	-47%
Hillsdale	3,562	2,089	(6)	56	412	32	972	1473	71%
Huron	5,646	5,519	(25)	1021	-1021	131	-4	127	2%
Ingham	7,113	2,892	(7)	1	311	2088	1822	4221	146%
Ionia	2,390	2,192	(9)	13	-297	360	122	198	9%
Iron	3,516	3,211	(11)	0	124	372	-191	305	10%
Isabella	2,536	3,684	(17)	-105	-893	98	-247	-1148	-31%
Kalkaska	3,111	1,555	(7)	54	974	579	-51	1556	100%
Keweenaw	665	259	(7)	166	162	25	53	406	157%
Lake	4,546	2,743	(10)	30	1213	396	165	1803	66%
Lapeer	3,284	2,201	(8)	60	667	690	-334	1083	49%
Lenawee	5,458	6,197	(12)	76	164	-174	-805	-739	-12%
Livingston	7,731	10,930	(20)	456	-331	-3337	13	-3199	-29%
Luce	864	96	(1)	0	211	364	193	768	799%
Mason	5,006	3,614	(19)	673	-586	515	789	1392	39%
Mecosta	4,322	6,609	(28)	-219	-2250	-64	246	-2287	-35%
Menominee	2,912	1,253	(27)	86	1677	366	-470	1659	132%

Table 17 (cont'd).

	Allocation Model	Survey Results[a]		Difference[b]				Percent Difference[c]
				Marina	Second Home	Waterfront Home	Nonwaterfront Home	All Segments	
Midland	4.028	6.083	(16)	14	-199	549	-2419	-2055	-34%
Missaukee	2.305	3.278	(12)	-59	-5	-720	-188	-973	-30%
Montcalm	5.418	6.426	(20)	173	404	-580	-1004	-1008	-16%
Montmorency	3.653	2.570	(12)	164	674	174	71	1083	42%
Oceana	3.946	2.604	(11)	92	529	-47	768	1342	52%
Ogemaw	4.534	3.013	(18)	76	1474	229	-258	1521	50%
Ontonagon	942	823	(10)	35	298	274	-488	119	14%
Osceola	2.944	3.186	(11)	16	53	-135	-177	-242	-8%
Oscoda	3.066	1.396	(6)	19	1423	129	99	1670	120%
Otsego	3.478	3.264	(10)	91	-5	-5	134	214	7%
Presque Isle	3.751	3.574	(20)	160	271	-42	-212	177	5%
Saginaw	6.560	5.596	(19)	-669	-411	228	1816	964	17%
Sanilac	3.142	2.101	(14)	-115	1265	-93	-16	1041	50%
Schoolcraft	2.534	555	(5)	31	1307	378	263	1979	357%
Shiawassee	2.535	1.348	(4)	4	105	816	263	1187	88%
St Joseph	5.047	4.047	(12)	299	-24	-768	1492	1000	25%
Tuscola	2.567	4.913	(24)	87	4	-315	-2123	-2346	-48%
Washtenaw	7.159	12.585	(21)	250	-1550	23	-4150	-5426	-43%
Wexford	3.529	4.182	(19)	42	-257	-177	-261	-653	-16%

a. Numbers in the parentheses are the unweighted count of boats in the storage county from the 1994 Michigan Boating Survey.

b. Difference is caculated as estimates from allocation model substract the estimates from survey observed.

c. Percent of difference is caculated as the difference over the estimates from survey observed.

Mackinac county, the model predicts half as many boats stored as the survey based estimates. The primary difference is the allocation of boats stored at second homes. The allocation model estimates 3,922 boats stored at second homes in the county (Table 14), compared to the survey estimate of 8,928 boats. The number of second homes in Mackinac county is estimated to be 4,039 (Michigan Housing Census, 1990). The survey estimate of boats stored at second homes is more than two times the number of second homes. It appears that the model estimate is more reasonable for Mackinac county.

For Newaygo county, the model estimate of the number of boats kept in the county is 40% less than the survey estimate. Again, there is a major difference in estimates of boats stored at second homes. The model estimates 2,280 boats stored at second homes in the county (Table 14), and the survey estimates 5,645 boats. It appears that the survey overestimates the number of boats stored at second homes. The estimate of 5,645 boats is higher than the estimate of the number of boats stored at second homes in Roscommon county, and Roscommon county has twice as many second homes as Newaygo county. It is unlikely that there are more boats at second homes in Newaygo than Roscommon. Newaygo county has 5,057 second homes; 500 less than the number of boats estimated by the survey to be stored at second homes.

BOAT DAYS IN COUNTIES

A trip generation model and a set of trip distribution models are used to predict the number of boat days in counties by boats in different types of storage. The models also provide origin-destination patterns of boats in storage segments. A trip generation

model first estimates the number of boat days generated by boats kept in each county. The trip distribution model then distributes these days to destination (use) counties.

Because almost all boat days by boats kept at waterfront homes, second homes, and marinas in inland counties, occur in the county where they are kept, all boat days are distributed to these counties. However, distinct two-step trip distribution models are required for boats stored at marinas in coastal counties and those stored at nonwaterfront homes. Figure 7 graphically describes these models (on page 57).

The presentation of the models is divided into four sections: (1) trip generation model which predicts number of boat days generated by boats kept in the counties, (2) trip distribution model for boats stored at marinas in coastal counties, (3) trip distribution model for boats stored at nonwaterfront homes, and (4) the summation of overall trip distribution models which estimate number of boat days in the (destination) counties by boats in different storage segments.

Trip Generation Model

Model Specification and Assumptions

The number of days generated by boats kept in counties is estimated by multiplying (1) the number of boats in each size-storage segment by (2) the average number of boat days for that segment. The generation model is formulated as:

$$T_{(i|s)} = \sum_{c=1}^{n} B_{(i|s,c)} * D_{(s|c)}$$

Where $T_{(i|s)}$: total boat days generated by boats kept in county i, given storage segment s.

$B_{(i,s,c)}$: number of boats kept in county i, given storage segment s and boat size c.

$D_{(s,c)}$: average boat days generated by boats in storage segment s, given boat size c.

Estimates of the number of boats in size-storage segments for each county are produced by the previous allocation model. Estimates of average boat days are based on the 1994 Michigan Boating Survey (Table 18). Average boat days range from 17 days for boats under 16 feet stored at nonwaterfront homes to 37 days for 16'-20' boats at waterfront homes. Marina boats are used most often, average of 31 days. Boats stored at nonwaterfront homes are used least frequently (17 days).

The trip generation model assumes that the average number of boat days for each segment does not vary significantly across counties. In other words, spatial variation in average boat days is explained by the differences in the mix of different boat sizes and types of storage.

Results and Evaluation

Approximately half of all boat days are generated by boats kept in the southeast and south-inland regions. About 30 percent of boat days are by boats stored at north inland, northwest, and northeast regions. Boats kept in the Upper Peninsula generate 8% of all boat days. Fifteen percent of boat days are by boats at marinas, 27% by boats at second homes, and the over half (58%) by boats stored at permanent waterfront and nonwaterfront homes (Table 19). Appendix D presents county level estimates.

Analysis of variance is used to test for the variations in boat days across regions, and variations across size-storage segments. The tests are performed to validate the use of

Table 18. Average Number Boat Days by Boat Size Class and Storage Segment.

Storage Segment	Boat Size	Average Number Boat Days
Marina Segment		*31.23*
	20 feet or smaller	30.26
	21-28 feet	30.90
	29 feet or larger	32.85
Second Home Segment		*25.07*
	Less than 16 feet	22.83
	16-20 feet	25.65
	21 feet or larger	31.59
Waterfront Home Segment		*30.44*
	Less than 16 feet	26.96
	16-20 feet	36.58
	21 feet or larger	28.22
Nonwaterfront Home Segment		*17.58*
	Less than 16 feet	17.14
	16 feet or larger	18.55

note: Estimates are based on the 1994 Michigan Boating Survey.

Table 19. Number of Boat Days Generated by Storage Segment and Storage Region.

STORAGE REGION	BOAT STORAGE SEGMENT Marina	Second Home	Waterfront Home	Nonwaterfront Home	TOTAL	(Percent)
Southeast	805,102	112,923	624,673	542,688	2,085,385	17.0%
Central East	196,810	129,475	46,761	215,287	588,333	4.8%
Northeast	90,946	422,743	166,309	110,351	790,348	6.4%
Northwest	224,380	508,346	317,183	204,245	1,254,154	10.2%
Central West	147,586	124,021	78,867	247,534	598,009	4.9%
Southwest	89,469	88,736	181,154	163,193	522,551	4.3%
South Inland	152,077	657,365	1,542,423	1,546,734	3,898,599	31.7%
North Inland	46,381	821,574	394,621	298,391	1,560,967	12.7%
South UP	23,666	353,594	101,052	66,154	544,466	4.4%
North UP	69,213	142,035	172,334	62,973	446,555	3.6%
Total	1,845,629	3,360,812	3,625,375	3,457,550	12,289,366	100.0%
(Percent)	15.0%	27.3%	29.5%	28.1%	100.0%	

note: Because cases with missing storage variables are excluded from the (survey based) estimates of boats in different storage segments by storage regions (Table 13) that are used to allocate boats to storage regions in the allocation models, the total number of boats estimated by storage allocation models is less than the number of registered active recreational watercraft (555,000 boats). Because the estimates by trip generation model are based on the estimates derived from the allocation models, the model estimated number of boat days is less than number of boat days (13.4 million days) reported in 1994 Recreational Boating Survey (Stynes et al., 1995).

state average boat days for different segments to estimate the number of boat days generated by the boats kept in counties. Probabilities of the F tests at the end of each column indicate regional variations in average boat days for different storage (size) segments. Probabilities of the F test at the end of each row indicate the variations of boat days across the storage (size) segments for different regions (Table 20).

Except for boats 21'-28' stored at marinas, there is no significant regional variation in boat days. Based on this result, it is acceptable to apply state average boat days for each segment to estimate number of boat days generated by boats kept in the counties. There are significant regional variations in boat days by boats 21'- 28' stored at marinas. The number of days ranges from 21 days in the northeast region to 58 days in the south UP region[24]. The average boat days (58 days) in south UP region significantly differ from the state average (31 days). This means that applying the state average boat days to boats 21'-28' stored at marinas would underestimate the total number of boat days generated in some counties (e.g., south UP) and overestimate days generated in other counties (e.g., northeast region).

Except for boats kept in the northern UP region, there are significant variations in boat days across size-storage segments. This confirms the assumption that variations in boat days are explained by the differences in boat storage type and boat size, not by the location where the boats are kept. It also supports the approach of applying state average boat days for each size-storage segment to estimate the total number of boat days generated by boats kept in the counties.

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[24] The estimated average boat days for 21'-28' boats stored at marinas in the inland south region is 60 days. This estimate is questionable as it is based on a sample of only few boats.

Table 20 Variations in Average Boat Days by Boats Within Size-Storage Segments and Storage Regions.

	BOAT STORAGE SEGMENTS											
	Marina			Second Home			Waterfront Home			Nonwaterfront Home		
Storage Region	20' or less	21'-28'	29' or larger	<16'	16'-20'	21' or larger	<16'	16'-20'	21' or larger	<16'	16' or larger	F prob.
Southeast	35	30	30	10	43	27	22	43	31	13	24	0.015
Central East	16	29	34	16	22	8	11	30	33	15	11	0.001
Northeast	25	21	34	15	20	35	26	29	23	16	14	0.006
Northwest	27	25	34	31	24	33	24	34	30	20	20	0.009
Central West	40	25	36	15	28	28	15	24	27	18	18	0.001
Southwest	25	29	38	58	26	28	30	29	23	31	12	0.030
South Inland	32	60	24	24	24	27	30	38	26	16	18	0.000
North Inland	35	35	37	22	22	30	31	31	25	20	16	0.044
South UP	NA	58	42	21	36	46	42	41	25	22	14	0.000
North UP	29	30	33	28	36	27	15	26	29	12	20	0.089
Segment Average	30	31	33	23	26	32	27	37	28	17	19	0.000
F prob.	0.490	0.002	0.102	0.169	0.896	0.089	0.611	0.778	0.910	0.179	0.159	

Trip Distribution Model For Boats Stored At Marinas In Coastal Counties

Model Specification

For each (storage) county, three types of destination zones are defined: (1) "within county" zone, (2) "nearby counties" zone, and (3) "more distant" zone. The "within county" zone is the (storage) county. The "nearby counties" are coastal counties bordering the (storage) county. The "more distant" zone consists of counties other than those bordering the (storage) county. For example, for St. Clair county, the "within county" zone is St. Clair county; the "nearby counties" zone includes Sanilac and Macomb counties; and the "more distant" zone includes all coastal counties other than St. Clair, Macomb and Sanilac counties.

The regional distribution of boat days within destination zones was estimated based on the 1994 Michigan Boating Survey. Most (83%) of the boat days generated by boats stored at marinas in coastal counties are within the county where the marina is located, 10% in the "nearby counties" zone, and the remaining 7% in the "more distant" zone. Over 85% of boat days generated by boats kept in the Upper Peninsula, northeast, and northwest regions are within the county where the boats are kept. Boats kept in the central-east, central-west, and northeast regions are more likely to take longer distance trips. More than 9% of boat days generated by boats in these regions are in the "more distant" zone (Table 21).

The estimated regional distribution is used to distribute boat days generated by boats in each storage county to one of the destination zones. For example, the southeast region's distribution is used for St. Clair county. Eighty-one percent of boat days

Table 21 Distribution of Boat Days by Destination Zone and Storage Region: Marina Segment.

	DESTINATION ZONES		
Storage Regions	"Within County" Zone	"Nearby Counties" Zone	"More Distant" Zone
Southeast	81.09%	12.37%	6.54%
Central East	77.47%	6.12%	16.42%
Northeast	86.08%	4.96%	8.96%
Northwest	88.42%	7.25%	4.32%
Central West	77.87%	13.00%	9.13%
Southwest	84.99%	7.64%	7.36%
South UP	95.12%	1.19%	3.69%
North UP	91.28%	6.23%	2.49%
Total	82.58%	10.04%	7.38%

note: Estimates are based on the 1994 Michigan Boating Survey.

generated by boats stored at marinas in St. Clair county are distributed to the St. Clair county, 12% to Macomb and Sanilac counties in "nearby counties" zone, and the remaining 7% to other coastal counties in "more distant" zone.

Several measures of a county's boating opportunities are used to distribute boat days to the counties within a destination zone. The length of Great Lakes shorelines is used as an indicator (SL indicator) of boating opportunities within the "nearby counties zone."[25] The "number of transient slips" and "number of transient nights in state-operated marinas" are combined into an cruising opportunity index (CP index) to distribute boat days to the counties within a "more distant" zone[26]. The "cruising opportunity" index is constructed as following:

$$CP_i = 1/2 *(Night_i + Slip_i) * W_{(i|r)}$$

Where CP_i: the cruising opportunity index for county i;
$Night_i$: standardized transient nights in county i[27];
$Slip_i$: standardized transient slips in county i; and
$W_{(i|r)}$: the weights assigned to county i, given region r[28].

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[25] Information on miles of Great Lakes shorelines in counties comes from Michigan Tourism Resource Database (Spotts, 1995).

[26] The number of transient slips in coastal counties was collected by the 1994 Great Lakes Marina Census. The number of transient nights at state-operated marinas in coastal counties was collected by the Michigan Department of Natural Resources.

[27] Standardized boating opportunity is calculated as the amount of boating opportunities in the county divided by the state average.

[28] The weights assigned to counties initially are based on the assumption that counties in northern Michigan are more attractive to long-distance boating trips, given the same boating opportunities. This is supported by the habitual "south-to-north" boating patterns described in many previous boating studies. After several calibrations, the final weights are "3" for counties in Upper Peninsula, northwest, central-west, and southeast regions, "2" for counties in southwest region, and "1" for counties in central-east and northeast regions. There are two reasons for assigning weight "3" to counties in the southeast region. First, 54% of all marina spaces are provided in southeast region. A portion of seasonal spaces would also be used by transient boats if they are not rented for the season. Therefore, the combination of transient nights at state-operated marinas and the transient slips in the county underestimates the capacities of the counties in southeast region to provide transient boating use. Second, travel distance is not included in the cruising opportunity index, and the 43% of marina boats are kept in southeast region. Assigning a weight of 3, to the counties in the southeast region may simply reflect the effects of travel distance and the mass of county's population.

The distributions of boating opportunity indices are provided in Appendix C. They show a county's attractiveness as a boating destination. They are used to distribute boat days into (destination) counties within different destination zones. The following county level distribution formula is used:

$$T_{(i|z)} = \frac{U_i}{\sum_{i \in \text{Destination zone } Z} U_i}$$

where $T_{(i|z)}$: number of boat days in county i, given destination zone z:
U_i : availability of boating opportunities in county i.
U_i = the miles of Great Lakes shorelines in the county for "nearby counties" zone.
U_i = The value of CP index (combination of number of transient slips and transient nights) in the county for "more distant" zone.

note: the formula distributes a share of boat days to each county in the destination zone in proportion to its share of total boating opportunities in the zone.

Assumptions

The trip distribution model for boats stored at marinas in coastal counties is based on three basic assumptions.

(1) The distributions of boat days within the three destination zones for each (storage) region are reliable.

(2) The distribution of Great Lakes shoreline captures the distribution of boat days within the "nearby counties" destination zone.

(3) The distribution of the cruising opportunity index reflects the number of boat days in counties within the "more distant" destination zone. In other words, the number of boat days attributed to long-distance cruising trips is

a function of the destination county's cruising opportunity index. Other factors, such as distance and directions do not have a significant impact.

Results

Table 22 summarizes the results from the trip distribution model for boats stored at marinas in coastal counties. About 57% of all boat days by boats stored at marinas in coastal counties take place in southeast and central-east regions. Sixteen percent are in Macomb county, which is more than the total number of marina boat days in any of the other regions.

Table 22 also shows the ratio of the number of boat days received in counties to the number of days generated by boats stored at marinas located in the counties. Ratios greater than one indicate that the region is a net importer of boat days. Regions with ratios less than one are net exporters. The southeast, east-central, and central west regions are "net exporting" regions. The other regions are "net importers," especially northeast, northwest, and Upper Peninsula regions. The net flows confirm the south-to-north boating (use) travel patterns.

Table 23 presents the origin (storage location) - destination (use location) matrix for boating by boats stored at marinas in the coastal counties. Over 90% of boat days in southeast, central-east, and central-west regions are by boats stored at marinas within the same region. The southeast region receives 766,000 boat days. About 97% of them are by boats kept in the region, 1.2% are by boats kept in the central-east region, and the remaining 1.4% are by boats kept in other regions. Comparatively, less boat days in northeast, northwest and UP south regions are by boats kept within those regions. The

Table 22 Boat Days by County of Origin (Storage) and Destination (Use): Marina Segment.

Counties/Regions	Total Boat Days by County of Destination[a] (A)	Percent	Total Boat Days by County of Origin (Storage)[b] (B)	Ratio (A)/(B)
Macomb	269,454	(16.4%)	300,077	90%
Monroe	142,990	(8.7%)	154,469	93%
St Clair	158,784	(9.6%)	153,277	104%
Wayne	194,368	(11.8%)	197,278	99%
SOUTHEAST REGION	***765,595***	***(46.5%)***	***805,102***	***95%***
Bay	87,877	(5.3%)	111,809	79%
Huron	45,233	(2.7%)	53,874	84%
Saginaw	2,732	(0.2%)	3,488	78%
Sanilac	27,029	(1.6%)	13,950	194%
Tuscola	13,839	(0.8%)	13,690	101%
CENTRAL EAST REGION	***176,710***	***(10.7%)***	***196,810***	***90%***
Alcona	4,388	(0.3%)	3,006	146%
Alpena	7,521	(0.5%)	6,904	109%
Arenac	24,748	(1.5%)	21,635	114%
Cheboygan	24,401	(1.5%)	21,695	112%
Iosco	29,260	(1.8%)	30,206	97%
Presque Isle	10,424	(0.6%)	7,499	139%
NORTH EAST REGION	***100,742***	***(6.1%)***	***90,946***	***111%***
Antrim	9,190	(0.6%)	7,440	124%
Benzie	27,770	(1.7%)	24,716	112%
Charlevoix	65,461	(4.0%)	60,950	107%
Emmet	29,118	(1.8%)	23,833	122%
Grand Traverse	15,257	(0.9%)	11,938	128%
Leelanau	40,507	(2.5%)	33,207	122%
Manistee	39,697	(2.4%)	38,756	102%
Mason	26,806	(1.6%)	23,539	114%
NORTHWEST REGION	***253,806***	***(15.4%)***	***224,380***	***113%***
Muskegon	50,890	(3.1%)	52,613	97%
Oceana	8,782	(0.5%)	3,726	236%
Ottawa	81,018	(4.9%)	91,246	89%
WEST CENTRAL REGION	***140,690***	***(8.5%)***	***147,586***	***95%***
Allegan	25,512	(1.5%)	20,358	125%
Berrien	44,967	(2.7%)	50,156	90%
Van Buren	24,987	(1.5%)	18,955	132%
SOUTHWEST REGION	***95,466***	***(5.8%)***	***89,469***	***107%***
Delta	7,133	(0.4%)	5,664	126%
Mackinac	22,556	(1.4%)	11,555	195%
Menominee	6,342	(0.4%)	5,461	116%
Schoolcraft	1,507	(0.1%)	986	153%
SOUTH UPPER PENINSULA	***37,538***	***(2.3%)***	***23,666***	***159%***
Alger	2,497	(0.2%)	1,844	135%
Baraga	10,144	(0.6%)	10,019	101%
Chippewa	30,093	(1.8%)	27,107	111%
Gogebic	2,724	(0.2%)	2,520	108%
Houghton	11,106	(0.7%)	9,650	115%
Keweenaw	7,014	(0.4%)	5,286	133%
Luce	191	(0.0%)	0	NA
Marquette	10,211	(0.6%)	10,204	100%
Ontonagon	2,642	(0.2%)	2,582	102%
NORTH UPPER PENINSULA	***76,623***	***(4.7%)***	***69,213***	***111%***
TOTAL	**1,647,171**	**(100%)**	**1,647,171**	**100%**

a Total number of boat days in the counties where the boats are used.

b Total number of boat days generated by boats kept in the counties.

note Because cases with missing storage variables are excluded from the (survey based) estimates of boats in different storage segments by storage regions (Table 13) that are used in the allocation models, the number of boats estimated by storage allocation models is less than the number of registered active craft (555,000 boats). Because the estimates by trip distribution model are based on the estimates derived from the generation and allocation models, the model estimated number of boat days would be lower than total number of boat days reported in 1994 Recreational Boating Survey (Stynes et al., 1995).

Table 23. Number of Boat Days by Storage Region and Destination Region: Marina Segment.

Boat Days	REGIONS OF STORAGE									
DESTINATION REGIONS	Southeast	Central East	Northeast	Northwest	Central West	Southwest	South UP	North UP	Total	(pct.)
South East	745,393	8,884	2,209	2,801	3,790	1,806	242	470	765,595	46.5%
Row pct.	*97.4%*	*1.2%*	*0.3%*	*0.4%*	*0.5%*	*0.2%*	*0.0%*	*0.1%*		
Column pct.	*92.6%*	*4.5%*	*2.4%*	*1.2%*	*2.6%*	*2.0%*	*1.0%*	*0.7%*		
Central East	14,141	160,047	919	493	667	318	43	83	176,710	10.7%
Row pct.	*8.0%*	*90.6%*	*0.5%*	*0.3%*	*0.4%*	*0.2%*	*0.0%*	*0.0%*		
Column pct.	*1.8%*	*81.3%*	*1.0%*	*0.2%*	*0.5%*	*0.4%*	*0.2%*	*0.1%*		
North East	6,542	8,065	82,209	1,478	1,471	701	94	182	100,742	6.1%
Row pct.	*6.5%*	*8.0%*	*81.6%*	*1.5%*	*1.5%*	*0.7%*	*0.1%*	*0.2%*		
Column pct.	*0.8%*	*4.1%*	*90.4%*	*0.7%*	*1.0%*	*0.8%*	*0.4%*	*0.3%*		
North West	18,737	9,513	2,950	215,361	4,446	2,007	269	522	253,806	15.4%
Row pct.	*7.4%*	*3.7%*	*1.2%*	*84.9%*	*1.8%*	*0.8%*	*0.1%*	*0.2%*		
Column pct.	*2.3%*	*4.8%*	*3.2%*	*96.0%*	*3.0%*	*2.2%*	*1.1%*	*0.8%*		
Central West	5,370	2,726	704	1,767	128,383	1,514	77	150	140,690	8.5%
Row pct	*3.8%*	*1.9%*	*0.5%*	*1.3%*	*91.3%*	*1.1%*	*0.1%*	*0.1%*		
Column pct.	*0.7%*	*1.4%*	*0.8%*	*0.8%*	*87.0%*	*1.7%*	*0.3%*	*0.2%*		
South West	3,885	1,972	509	646	6,349	81,941	56	108	95,466	5.8%
Row pct.	*4.1%*	*2.1%*	*0.5%*	*0.7%*	*6.7%*	*85.8%*	*0.1%*	*0.1%*		
Column pct.	*0.5%*	*1.0%*	*0.6%*	*0.3%*	*4.3%*	*91.6%*	*0.2%*	*0.2%*		
South UP	6,168	3,132	808	1,025	1,387	661	22,708	1,649	37,538	2.3%
Row pct.	*16.4%*	*8.3%*	*2.2%*	*2.7%*	*3.7%*	*1.8%*	*60.5%*	*4.4%*		
Column pct.	*0.8%*	*1.6%*	*0.9%*	*0.5%*	*0.9%*	*0.7%*	*96.0%*	*2.4%*		
North UP	4,866	2,470	638	809	1,094	521	177	66,049	76,623	4.7%
Row pct.	*6.3%*	*3.2%*	*0.8%*	*1.1%*	*1.4%*	*0.7%*	*0.2%*	*86.2%*		
Column pct.	*0.6%*	*1.3%*	*0.7%*	*0.4%*	*0.7%*	*0.6%*	*0.7%*	*95.4%*		
Total	805,102	196,810	90,946	224,380	147,586	89,469	23,666	69,213	1,647,171	
(percent)	*48.9%*	*11.9%*	*5.5%*	*13.6%*	*9.0%*	*5.4%*	*1.4%*	*4.2%*		

northeast region receives 101,000 boat days. About 82% are by boats kept within the region, 15% by boats in southeast and central-east regions, and the other 4% by boats kept in other regions.

The origin - destination matrix also reveals some potential problems associated with distributing boat days to counties in the "more distant" zone without incorporating the impact of travel distance. For example, 16% of boat days (6,000 days) in the south UP region are by boats kept in the southeast region. Only 5% (1,800 days) are by boats kept in the northeast and northwest regions. It is questionable whether boats kept in the southeast region would account for three times more boat days than boats kept in northeast and northwest regions, given that these regions are much closer. However, the southeast region is a major exporter of boat days to northern regions including the Upper Peninsula, so it is possible.

Model Evaluation

The distribution model is evaluated on its ability to distribute boat days (1) first to destination zones and (2) then to counties. Estimates from the two steps are evaluated separately. The percentage of boat days within each destination zone by (storage) regions is estimated from the 1994 Michigan Boating Survey. The model uses these estimates to distribute boat days to destination zones. Sampling errors are calculated for the estimated distribution. The sampling errors indicate the range of accuracy for number of boat days in the destination zone. The estimates of number of boat days in regions/counties are evaluated by comparing the distribution model estimates and direct survey estimates.

Table 24 provides estimated sampling errors at a 95 percent confidence level for the estimated distribution of boat days by (storage) regions. For example, the model estimates that 82.6% of all boat days by boats stored at marinas in coastal counties occur in the "within county" destination zone. The sampling error for this estimate is 2.4% at the 95% confidence level. Therefore, at the 95% confidence level, the percentage of marina boat days occurring at the "within county" destination zone is between 80% to 85%.

Most of the sampling errors are around 5%. The largest sampling errors (10-13%) are in the south UP region due to the small sample size (50 boats). Because of these large sampling errors, the estimated distribution of marina boat days within destination zones in the south UP region is less reliable than for other regions. The 13% sampling error at a 95 percent confidence level means that the number of boat days in the "within county" zone could range from 19,000 days (82%) to 23,666 days (100%) for boats kept at marinas in the south Upper Peninsula region.

The second stage of the evaluation is an examination of the model produced estimates of number of boat days in counties. The model estimates are compared with survey based estimates. Two types of model estimates (A and B) are made, depending on the form of model input: (1) survey based estimates of boat days generated by boats kept in counties (model estimates A), and (2) estimates of boat days in the storage counties produced by the trip generation model (model estimates B).

The marina boat days allocation model, marina trip generation model, and marina trip distribution model are linked together. The number of boats stored at marinas in

Table 24 Marina Boat Days by Storage Region and Destination Zone: Sampling Errors at A 95% Confidence Interval.

	STORAGE REGIONS								ALL
DESTINATION ZONES	Southeast	Central East	Northeast	Northwest	Central West	Southwest	South UP	North UP	
Sampling Error at 95% Confidence Interval									
"Within County" Zone	5.17%	6.47%	7.13%	5.30%	6.51%	7.68%	12.93%	8.97%	2.40%
"Nearby Counties" Zone	4.66%	4.62%	5.37%	4.26%	5.39%	6.34%	9.62%	7.48%	1.96%
"More Distant" Zone	3.83%	6.03%	6.89%	4.76%	5.58%	6.64%	10.65%	7.12%	2.08%
Distribution of Boat Days in Destination Zones									
"Within County" Zone	81.1%	77.5%	86.1%	88.4%	77.9%	85.0%	95.1%	91.3%	82.6%
"Nearby Counties" Zone	12.4%	6.1%	5.0%	7.3%	13.0%	7.6%	1.2%	6.2%	10.0%
"More Distant" Zone	6.5%	16.4%	9.0%	4.3%	9.1%	7.4%	3.7%	2.5%	7.4%
No. of Boat Days	*805,102*	*196,810*	*90,946*	*224,380*	*147,586*	*89,469*	*23,666*	*69,213*	*1,647,171*
No. of Samples	*354*	*228*	*188*	*341*	*225*	*162*	*50*	*114*	*1662*

counties estimated by the marina boat allocation model is an input to the trip generation model. The number of boat days generated by boats kept in counties estimated by the trip generation model is an input to the trip distribution model. The potential problem associated with connecting the set of models is that the systematic errors produced by one model can carry over to the next model. In order to independently evaluate the performance of the trip distribution model without accumulated errors (influences) contributed by other models, survey-based estimates of boat days by boats kept at marinas are also used as the initial inputs to the trip distribution model.

The percent difference between model estimates (A) and direct survey estimates range from 1% in Monroe county to 1730% in Schoolcraft county. Only one boat was sampled in Schoolcraft county, so the survey-based estimate is quite unreliable. Twenty one of 42 coastal counties have sample sizes of less than 30 boats. Only 21 counties have sample sizes greater than 30 boats. Most counties with more than a 100% percent difference between the two estimates have a sample size of less than 30 boats.

The twenty-one counties with sample sizes greater than 30 boats provide a better basis for evaluating the trip distribution model (Table 25). For all of these counties, the percent difference between direct survey estimates and model estimates (A) are 20% or less, and for two thirds of them the difference is less than 10%. The model estimates (A) are 20% less than direct survey estimates of the number of boat days in Huron and Iosco counties.

The trip distribution model for boats kept at marinas in coastal counties performs reasonably well for counties in the southeast, northeast, northwest, and southwest regions.

Table 25 Marina Boat Days by County of Destination; A Comparison of Survey and Model Estimates.

REGION/COUNTY	NUMBER OF BOAT DAYS Survey Estimate		Model Estimate			
			Model Input from 1994 Survey[a]		Model Input from Previous Model[b]	
		No Cases	(A)	Percent Difference[c]	(B)	Percent Difference[c]
Regional Estimates						
Southeast Region	823,367	321	796,138	-3%	765,595	-7%
Central East Region	139,359	173	152,314	9%	176,710	27%
Northeast Region	85,396	184	86,366	1%	100,742	18%
Northwest Region	234,927	340	237,932	1%	253,806	8%
Central West Region	145,910	190	145,048	-1%	140,690	-4%
Southwest Region	96,918	132	101,414	5%	95,466	-1%
South Upper Peninsula	42,508	91	48,661	14%	37,538	-12%
North Upper Peninsula	78,786	128	79,298	1%	76,623	-3%
TOTAL	1,647,171		1,647,171	0%	1,647,171	0%
County Level Estimates For Counties With Sample Sizes Larger Than 30 Boats						
Allegan	32,250	48	30,513	-5%	25,512	-21%
Arenac	34,478	39	31,584	-8%	24,748	-28%
Bay	98,719	108	91,803	-7%	87,877	-11%
Berrien	36,525	45	37,403	2%	44,967	23%
Charlevoix	40,090	65	42,878	7%	65,461	63%
Cheboygan	29,242	55	32,017	9%	24,401	-17%
Emmet	43,867	66	43,517	-1%	29,118	-34%
Grand Traverse	17,330	35	18,807	9%	15,257	-12%
Huron	19,430	34	15,567	-20%	45,233	133%
Iosco	12,336	45	9,899	-20%	29,260	137%
Leelanau	38,281	73	40,424	6%	40,507	6%
Mackinac	33,222	54	36,094	9%	22,556	-32%
Macomb	204,719	89	229,721	12%	269,454	32%
Marquette	21,442	34	21,963	2%	10,211	-52%
Manistee	46,840	37	45,435	-3%	39,697	-15%
Monroe	109,144	45	108,470	-1%	142,990	31%
Muskegon	84,865	82	71,784	-15%	50,890	-40%
Ottawa	55,496	86	64,938	17%	81,018	46%
St Clair	238,076	88	220,617	-7%	158,784	-33%
Van Buren	28,143	39	33,497	19%	24,987	-11%
Wayne	271,428	99	237,331	-13%	194,368	-28%
County Level Estimates For Counties With Sample Sizes Smaller Than 30 Boats						
Alcona	1,447	16	2,257	56%	4,388	203%
Alger	10,070	7	10,143	1%	2,497	-75%
Alpena	2,116	13	3,255	54%	7,521	255%
Antrim	25,072	27	23,346	-7%	9,190	-63%
Baraga	13,567	13	13,871	2%	10,144	-25%
Benzie	19,785	26	14,804	-25%	27,770	40%
Chippewa	18,966	26	15,911	-16%	30,093	59%
Delta	6,389	21	8,220	29%	7,133	12%
Gogebic	1,521	4	1,848	22%	2,724	79%
Houghton	7,651	21	11,972	56%	11,106	45%
Keweenaw	4,679	15	2,361	-50%	7,014	50%
Luce	-	2	237	NA	191	NA
Mason	3,661	11	8,720	138%	26,806	632%
Menominee	2,865	15	3,766	31%	6,342	121%
Oceana	5,548	22	8,327	50%	8,782	58%
Ontonagon	890	6	992	11%	2,642	197%
Presque Isle	5,777	16	7,354	27%	10,424	80%
Saginaw	4,772	4	7,965	67%	2,732	-43%
Sanilac	10,318	16	27,672	168%	27,029	162%
Schoolcraft	32	1	580	1730%	1,507	4658%
Tuscola	6,121	11	9,308	52%	13,839	126%

a The model input, number of boat days in the storage counties, are generated directly from the 1994 Michigan Boating Survey.

b The model input, number of boat days in the storage counties, are generated from previous boat days generation model

c Percent differences are calculated as (model estimate - survey estimate) / survey estimate.

Differences between direct survey estimates and model estimates (A) are within 5% for these regions. Percent differences at regional level are larger for the central-east (9%) and south Upper Peninsula regions (14%).

Differences between direct survey estimates and model estimates (B) are generally larger than differences between direct survey estimates and model estimates (A). This is largely due to the compounding effects (errors) from the previous models associated with model estimate (B). The percent differences range from 6% to 137%. The percent differences are less than 35% for 15 of 21 counties with sample sizes of more than 30 boats.

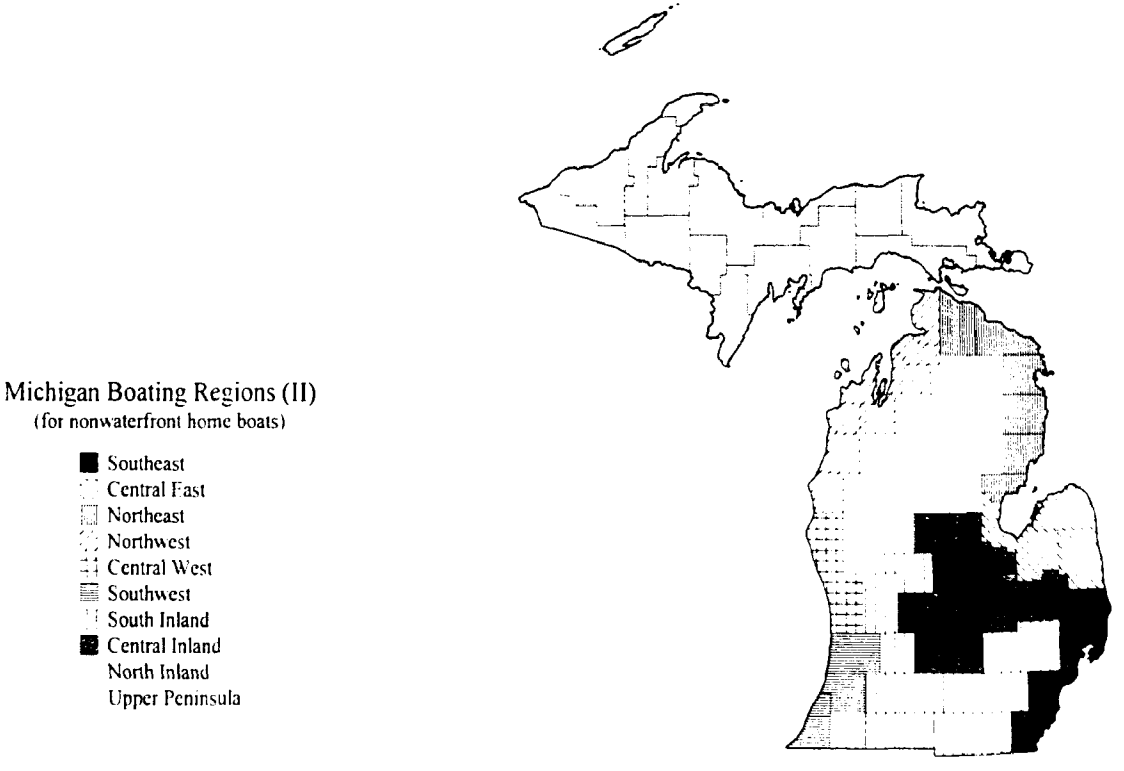
Regional estimates directly from the survey are similar to model estimates (B). The two estimates are within 10% for the southeast, northwest, west central, southwest, and north Upper Peninsula regions. The largest regional percent differences between survey estimates and model estimates (B) are for the central-east (27%) and northeast regions (18%).

Trip Distribution Model for Boats Stored at Nonwaterfront Homes

Model Specification

The regions used in the trip distribution model for boats stored at nonwaterfront homes are slightly different from the regions in other models. The regions are shown in the Figure 9. Inland counties are grouped into the south-inland, central-inland, and north inland regions. The central-inland region has few water resources, such as lakes and rivers. The south and north Upper Peninsula regions are combined into one region.

Figure 9 Michigan Boating Regions (II).



For each (storage) county, 13 time-distance destination zones were defined: "within 20 miles", "21-60 miles", "61-90 miles", "91-120 miles", "121-150 miles", "151-180 miles", "181-210 miles", "211-240 miles", "241-270 miles", "271-300 miles", "301-360 miles", "361-420 miles", and "over 421 miles". Each zone includes one or more (destination) counties.

The distribution of boat days in destination zones within (storage) regions was estimated from the 1994 Michigan Boating Survey (Table 26 and Figure 10). As would be expected, the percentage of boat days in each zone generally declines as distance increases since boats kept at non-waterfront homes must be trailered to waterfront locations. The greater the distance the higher the travel cost - time and money costs - associated with using these boats. Although the number of boat days generally decreases as distance increases, some fluctuations occur in the distance decay curve. These fluctuations may be the result of several factors, such as the availability of boating opportunities and facilities, boater travel habits, and agglomeration effects of counties in the destination zone.

The patterns of boat days distribution within destination zones vary somewhat across regions. In northern Michigan, over 85% of boat days by boats stored at nonwaterfront homes take place in the "within 20 miles" zone. In southern Michigan regions, less than 55% of boat days occur in the "within 20 miles" zone. Travel propensity is influenced by the amount and quality of boating opportunities within the origin (storage) counties. Owners of boats kept in counties that have more and/or higher

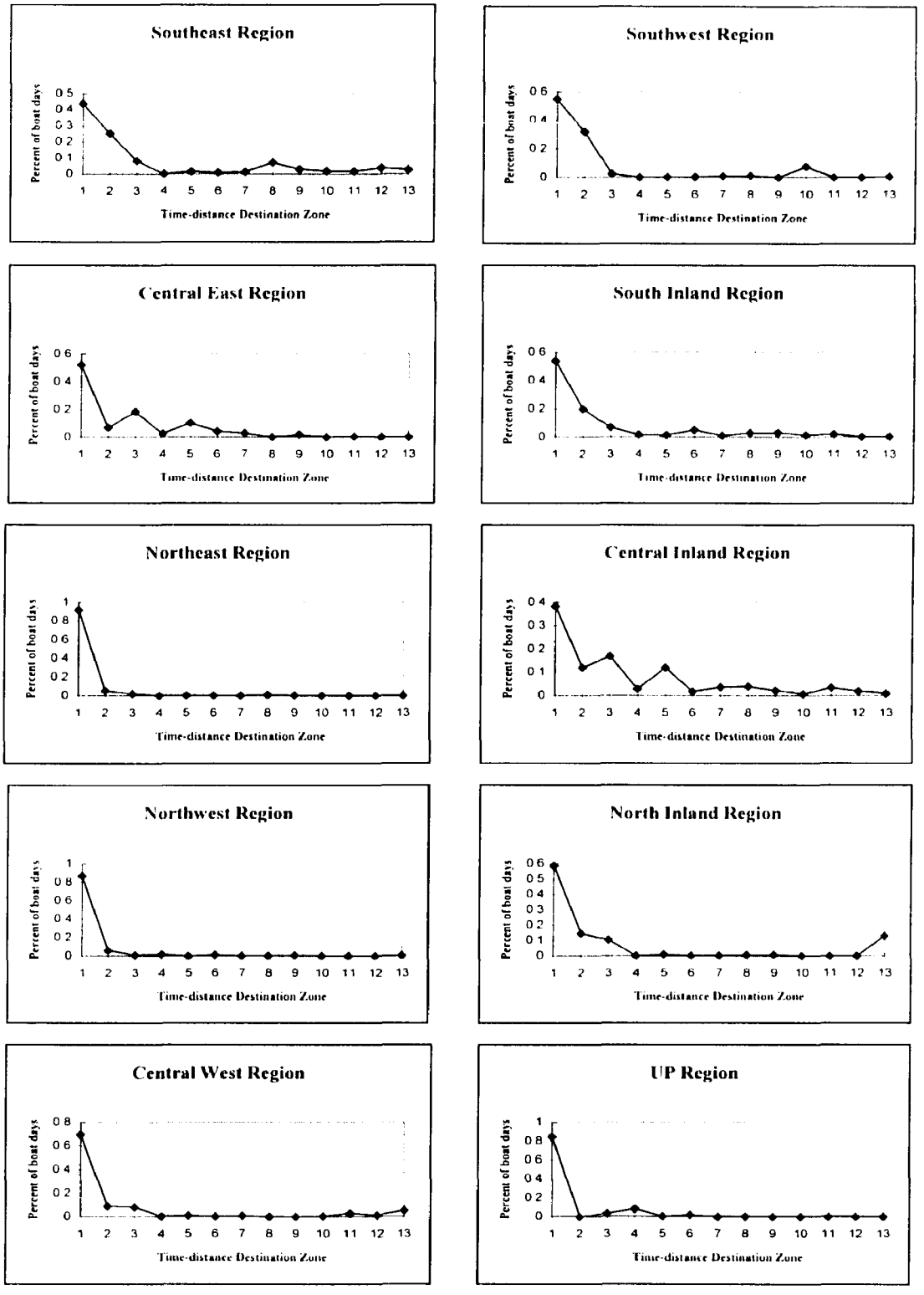
Table 26. Distribution of Boat Days By Storage Region and Time Distance Destination Zone; Nonwaterfront Home Segment.

Time-distance Destination Zones	South East[a]	Central East	North East	North West	Central West	South West	South Inland	Central Inland	North Inland	U.P.	Total
Within 20 miles	44%	52%	92%	87%	70%	55%	54%	38%	59%	85%	56%
21-60 miles	25%	7%	5%	6%	9%	32%	20%	12%	15%	0%	16%
61-90 miles	8%	18%	2%	1%	8%	3%	7%	17%	11%	4%	8%
91-120 miles	0%	3%	0%	2%	0%	0%	2%	3%	0%	8%	2%
121-150 miles	2%	10%	0%	0%	1%	0%	1%	12%	1%	1%	3%
151-180 miles	1%	4%	0%	1%	0%	0%	5%	2%	0%	2%	2%
181-210 miles	1%	3%	0%	0%	1%	1%	1%	4%	0%	0%	1%
211-240 miles	7%	0%	1%	0%	0%	1%	3%	4%	1%	0%	3%
241-270 miles	3%	2%	0%	1%	0%	0%	3%	2%	1%	0%	2%
271-300 miles	2%	0%	0%	0%	0%	8%	1%	1%	0%	0%	1%
301-360 miles	2%	0%	0%	0%	3%	0%	2%	3%	0%	0%	2%
361-420 miles	4%	0%	0%	0%	1%	0%	0%	2%	0%	0%	1%
Over 420 miles	3%	0%	0%	1%	5%	1%	0%	1%	13%	0%	2%

a. For each county in the southeast region, 44% of the boat days by boats kept in nonwaterfront homes are allocated to the "within 20 miles" time-distance destination zone.

note: Estimates are based on the 1994 Michigan Boating Survey.

Figure 10. Distribution of Boat Days by Destination Zone and Storage Region; Nonwaterfront Home Segment.



quality boating opportunities have a lower propensity to travel than in counties with fewer or lower quality boating opportunities.

Assuming the regional distributions apply to all counties in the region, boat days generated by boats stored at nonwaterfront homes are distributed from each origin (storage) county to the destination zones. For example, the northeast region's distribution is used for Alcona county to distribute boat days to destination zones, 82% of days to the "within 20 miles" zone, 5% to the "21-60 miles" zone, 2% to the "61-90 miles" zone, and 1% to the "211-240 miles" zone.

Step two of the distribution model is to distribute boat days to counties within each destination zone in order to estimate total number of boat days in the (destination) counties. An index of boating opportunities (TR index) -- a weighted combination[29] of "acres of lakes", "acres of inland water", "miles of Great Lakes shorelines", "miles of state or federally-designated wild and scenic/natural rivers", "number of lakes over 50 acres", "number of Great Lakes access sites", and "number of campgrounds" -- is employed to distribute boat days to the counties within destination zones[30]. The index for each county is constructed as following:

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[29] Initially 40 variables measuring the quantity and quality of boating-related resources, facilities, and activities were potential candidates to construct the boating opportunity index. Net flow ratios for each county (number of boat days in the counties divided by number of boat days generated by boats kept in the county) which serve as a proxy measure of a county's attractiveness to boats at nonwaterfront homes are calculated. The correlation analysis and step-wise multiple regression analysis are used to assist the decisions on the variables and weights for the variables comprising the boating opportunity index.

[30] The acres of lakes, and number of lakes over 50 acres were collected in "Michigan Lake Inventory" (MDNR, 1974).

Miles of Great Lakes shorelines, acres of inland water, miles of state or federally-designated wild and scenic/natural rivers, number of Great Lakes access sites, and number of campgrounds in the counties are assembled in the Michigan Tourism Resources Database (Spotts, 1995).

$$TR_i = (4*R_i + 4*G_i + 2.5*WT_i + 1.5*LK_i + 1.5*LK50_i + 1*AC_i + 1*CM_i)* W_{(i|r)}$$

Where TR_i: the boating opportunity index for county i;
R_i: standardized miles of scenic/nature rivers in county i[31];
G_i: standardized miles of Great Lakes shorelines in county i;
WT_i: standardized acres of inland water in county i;
LK_i: standardized acres of lakes in county i;
AC_i: standardized number of public access sites on Great Lakes in county i;
CM_i: standardized number of campgrounds in county i; and
$W_{(i|r)}$: the weights assigned to county i, given region r[32].

The index measures a county's attractiveness as a destination for boats stored at nonwaterfront homes. The county level distribution formula (on page 100) is applied to distribute boat days by boats stored at nonwaterfront homes to counties within a destination zone. The TR index is used in the formula to measure the availability of boating opportunity in the county (U_i).

Assumptions

The trip distribution model for boats stored at nonwaterfront homes involves two basic assumptions.

(1) The regional distribution of boat days within 13 destination zones is reliable.

(2) The distribution of boating opportunity index (TR index) reflects the number of boat days that occur in the counties within a time-distance destination zone.

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[31] The standardized measure of a resource in a county is calculated as the amount of a resource in the county divided by the state average amount of that resource.

[32] The weights assigned to counties are based on the assumption -- the counties in the northern Michigan are more attractive, given the same boating opportunities -- which could be supported by the "south to north" habitual boating patterns found in many previous boating studies. After several calibrations, the final weights are "2.5" for counties in the Upper Peninsula, northwest region, northeast, central-east, and north-inland regions, "0.5" for counties in the central-inland and southeast regions, and "1.5" for the other counties.

Results

Table 27 summarizes the distribution of boat days for boats stored at nonwaterfront homes. About 30% of boat days generated by boats stored at nonwaterfront homes take place in the south-inland region. Except for a couple of counties with large populations, most counties house 1% to 2% of these boat days. For example, 7% of the days occur in Oakland county and 5% of the days take place in Wayne county.

The ratios of boat days that take place in a county by boats stored at nonwaterfront homes to the number of boat days generated by boats stored at nonwaterfront homes in the county indicates counties that either export or import boat days. Ratios greater than one indicate counties that are net importers of boat days. Ratios less than one indicate counties that are net exporters. Southeast and central-inland regions are "net exporters", and northeast, northwest, north-inland and Upper Peninsula regions are "net importing" regions. The net flows capture the south-to-north boating (use) travel patterns.

Table 28 presents the origin (storage location) - destination (use location) matrix for boats stored at nonwaterfront homes. Over three quarters of boat days in the southern Michigan regions - southeast, central-west, south-inland and central-inland regions - are by boats kept within the same region. In the central-inland region, 92% of days are by the boats kept within the region. But, less than half (42%) of days generated by boats kept in this region stay within the region. This is because the central-inland region has relatively few lakes and boating opportunities. In comparison, in northern Michigan regions - northeast, central-east, northwest, north-inland and Upper Peninsula regions -

Table 27. Boat Days By County of Origin (Storage) and Destination (Use): Nonwaterfront Home Segment.

Counties/ Regions	Total Boat Days by County of Destination[a] (A)	(pct.)	Total Boat Days by County of Origin (Storage)[b] (B)	Ratio (A)/(B)
Macomb	105,954	(3.1%)	175,897	60%
Monroe	41,359	(1.2%)	38,547	107%
St Clair	67,620	(2.0%)	52,048	130%
Wayne	173,021	(5.0%)	276,196	63%
South East	***387,953***	***(11.2%)***	***542,688***	***71%***
Bay	65,768	(1.9%)	59,388	111%
Huron	35,713	(1.0%)	18,028	198%
Sanilac	19,873	(0.6%)	12,642	157%
Tuscola	36,683	(1.1%)	26,803	137%
Central East	***158,037***	***(4.6%)***	***116,861***	***135%***
Alcona	25,688	(0.7%)	11,345	226%
Alpena	31,846	(0.9%)	22,077	144%
Arenac	45,564	(1.3%)	15,208	300%
Cheboygan	37,818	(1.1%)	23,348	162%
Iosco	39,165	(1.1%)	25,020	157%
Presque Isle	22,677	(0.7%)	13,354	170%
Northeast	***202,757***	***(5.9%)***	***110,351***	***184%***
Antrim	30,232	(0.9%)	23,826	127%
Benzie	26,993	(0.8%)	17,205	157%
Charlevoix	35,537	(1.0%)	20,580	173%
Emmet	29,866	(0.9%)	23,125	129%
Grand Traverse	72,242	(2.1%)	58,480	124%
Leelanau	35,893	(1.0%)	22,989	156%
Manistee	28,757	(0.8%)	17,711	162%
Mason	42,712	(1.2%)	20,328	210%
Northwest	***302,232***	***(8.7%)***	***204,245***	***148%***
Muskegon	90,008	(2.6%)	94,241	96%
Oceana	26,859	(0.8%)	17,388	154%
Ottawa	120,364	(3.5%)	135,905	89%
Central West	***237,231***	***(6.9%)***	***247,534***	***96%***
Allegan	78,189	(2.3%)	52,555	149%
Berrien	46,007	(1.3%)	69,377	66%
Van Buren	50,887	(1.5%)	41,260	123%
Southwest	***175,083***	***(5.1%)***	***163,193***	***107%***
Barry	38,964	(1.1%)	38,925	100%
Branch	28,809	(0.8%)	28,800	100%
Calhoun	41,908	(1.2%)	52,343	80%
Cass	41,045	(1.2%)	38,495	107%
Hillsdale	18,547	(0.5%)	21,235	87%
Jackson	73,402	(2.1%)	70,345	104%
Kalamazoo	68,222	(2.0%)	87,213	78%
Kent	153,637	(4.4%)	196,582	78%
Lenawee	33,220	(1.0%)	38,735	86%
Livingston	111,396	(3.2%)	63,386	176%
Montcalm	38,049	(1.1%)	31,539	121%
Oakland	246,737	(7.1%)	325,217	76%
Saint Joseph	35,276	(1.0%)	39,645	89%
Washtenaw	91,180	(2.6%)	67,483	135%
South Inland	***1,020,391***	***(29.5%)***	***1,099,944***	***93%***

Table 27 (cont'd).

Counties/ Regions	Total Boat Days by County of Destination[a] (A)	(pct.)	Total Boat Days by County of Origin (Storage)[b] (B)	Ratio (A)/(B)
Clinton	12,889	(0.4%)	28,327	46%
Eaton	16,527	(0.5%)	39,067	42%
Genesee	68,006	(2.0%)	143,565	47%
Gratiot	7,090	(0.2%)	16,322	43%
Ingham	32,708	(0.9%)	78,029	42%
Ionia	17,148	(0.5%)	23,745	72%
Isabella	9,105	(0.3%)	19,530	47%
Lapeer	15,987	(0.5%)	28,923	55%
Midland	16,999	(0.5%)	41,216	41%
Saginaw	38,778	(1.1%)	98,426	39%
Shiawassee	11,270	(0.3%)	28,066	40%
Central Inland	***246,509***	***(7.1%)***	***545,216***	***45%***
Clare	26,622	(0.8%)	25,244	105%
Crawford	39,439	(1.1%)	13,515	292%
Gladwin	28,165	(0.8%)	24,725	114%
Kalkaska	16,708	(0.5%)	14,985	111%
Lake	31,474	(0.9%)	11,416	276%
Mecosta	25,217	(0.7%)	26,698	94%
Missaukee	10,626	(0.3%)	11,735	91%
Montmorency	11,827	(0.3%)	13,356	89%
Newaygo	60,774	(1.8%)	36,924	165%
Ogemaw	38,191	(1.1%)	18,946	202%
Osceola	15,631	(0.5%)	14,959	104%
Oscoda	30,988	(0.9%)	9,906	313%
Otsego	24,803	(0.7%)	17,368	143%
Roscommon	47,087	(1.4%)	33,695	140%
Wexford	23,452	(0.7%)	24,919	94%
North Inland	***431,003***	***(12.5%)***	***298,391***	***144%***
Delta	12,195	(0.4%)	4,351	280%
Dickinson	9,511	(0.3%)	2,617	363%
Iron	49,755	(1.4%)	12,967	384%
Mackinac	25,939	(0.8%)	17,191	151%
Menominee	11,981	(0.3%)	12,502	96%
Schoolcraft	18,394	(0.5%)	6,748	273%
Alger	14,175	(0.4%)	8,811	161%
Baraga	14,778	(0.4%)	8,987	164%
Chippewa	20,814	(0.6%)	935	2226%
Gogebic	17,657	(0.5%)	3,381	522%
Houghton	36,672	(1.1%)	10,942	335%
Keweenaw	22,439	(0.6%)	19,885	113%
Luce	9,990	(0.3%)	9,613	104%
Marquette	12,193	(0.4%)	3,278	372%
Ontonagon	19,863	(0.6%)	6,920	287%
Upper Peninsula	***296,354***	***(8.6%)***	***129,127***	***230%***
STATE TOTAL	**3,457,550**		**3,457,550**	

a. Total number of boat days in the counties where the boats are used.

b. Total number of boat days generated by boats kept in the counties.

note: Because cases with missing storage variables are excluded from the (survey based) estimates of boats in different storage segments by storage regions (Table 13) that are used in the allocation models, the number of boats estimated by storage allocation models is less than the number of registered active craft (555,000 boats). Because the estimates by trip distribution model are based on the estimates derived from the generation and allocation models, the model estimated number of boat days would be lower than total number of boat days reported in 1994 Recreational Boating Survey (Stynes et al., 1995).

Table 28. Number of Boat Days by Storage Region and Destination Region: Nonwaterfront Home Segment.

Boat Days	REGIONS OF STORAGE										TOTAL	
DESTINATION REGIONS	Southeast	Central East	Northeast	Northwest	Central West	Southwest	South Inalnd	Central Inland	North Inland	UP		(pct.)
Southeast	307,967	2,424	9	0	57	212	61,632	15,391	260	0	387,953	11%
Row Pct.	*79.4%*	*0.6%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*15.9%*	*4.0%*	*0.1%*	*0.0%*		
Column Pct.	*56.7%*	*2.1%*	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*5.6%*	*2.8%*	*0.1%*	*0.0%*		
Central East	9,202	77,044	354	623	461	2,160	21,270	45,175	1,745	3	158,037	5%
Row Pct.	*5.8%*	*48.8%*	*0.2%*	*0.4%*	*0.3%*	*1.4%*	*13.5%*	*28.6%*	*1.1%*	*0.0%*		
Column Pct.	*1.7%*	*65.9%*	*0.3%*	*0.3%*	*0.2%*	*1.3%*	*1.9%*	*8.3%*	*0.6%*	*0.0%*		
Northeast	11,017	10,594	105,047	2,324	3,405	1,207	26,340	34,030	8,042	750	202,757	6%
Row Pct.	*5.4%*	*5.2%*	*51.8%*	*1.1%*	*1.7%*	*0.6%*	*13.0%*	*16.8%*	*4.0%*	*0.4%*		
Column Pct.	*2.0%*	*9.1%*	*95.2%*	*1.1%*	*1.4%*	*0.7%*	*2.4%*	*6.2%*	*2.7%*	*0.6%*		
Northwest	10,663	3,212	973	190,036	7,614	6,515	43,997	23,075	15,360	787	302,232	9%
Row Pct.	*3.5%*	*1.1%*	*0.3%*	*62.9%*	*2.5%*	*2.2%*	*14.6%*	*7.6%*	*5.1%*	*0.3%*		
Column Pct.	*2.0%*	*2.7%*	*0.9%*	*93.0%*	*3.1%*	*4.0%*	*4.0%*	*4.2%*	*5.1%*	*0.6%*		
Central West	6,599	352	35	925	183,360	4,723	26,637	8,056	6,544	0	237,231	7%
Row Pct.	*2.8%*	*0.1%*	*0.0%*	*0.4%*	*77.3%*	*2.0%*	*11.2%*	*3.4%*	*2.8%*	*0.0%*		
Column Pct.	*1.2%*	*0.3%*	*0.0%*	*0.5%*	*74.1%*	*2.9%*	*2.4%*	*1.5%*	*2.2%*	*0.0%*		
Southwest	2,903	136	5	167	5,826	113,608	46,481	5,686	271	0	175,083	5%
Row Pct.	*1.7%*	*0.1%*	*0.0%*	*0.1%*	*3.3%*	*64.9%*	*26.5%*	*3.2%*	*0.2%*	*0.0%*		
Column Pct.	*0.5%*	*0.1%*	*0.0%*	*0.1%*	*2.4%*	*69.6%*	*4.2%*	*1.0%*	*0.1%*	*0.0%*		
South Inalnd	110,012	3,671	91	808	13,089	28,109	775,446	86,349	2,816	0	1,020,391	30%
Row Pct.	*10.8%*	*0.4%*	*0.0%*	*0.1%*	*1.3%*	*2.8%*	*76.0%*	*8.5%*	*0.3%*	*0.0%*		
Column Pct.	*20.3%*	*3.1%*	*0.1%*	*0.4%*	*5.3%*	*17.2%*	*70.5%*	*15.8%*	*0.9%*	*0.0%*		
Central Inland	4,092	1,039	10	51	236	79	12,886	227,649	466	0	246,509	7%
Row Pct.	*1.7%*	*0.4%*	*0.0%*	*0.0%*	*0.1%*	*0.0%*	*5.2%*	*92.3%*	*0.2%*	*0.0%*		
Column Pct.	*0.8%*	*0.9%*	*0.0%*	*0.0%*	*0.1%*	*0.0%*	*1.2%*	*41.8%*	*0.2%*	*0.0%*		
North Inland	43,278	17,042	3,049	5,686	12,843	5,609	63,533	58,487	221,066	412	431,003	12%
Row Pct.	*10.0%*	*4.0%*	*0.7%*	*1.3%*	*3.0%*	*1.3%*	*14.7%*	*13.6%*	*51.3%*	*0.1%*		
Column Pct.	*8.0%*	*14.6%*	*2.8%*	*2.8%*	*5.2%*	*3.4%*	*5.8%*	*10.7%*	*74.1%*	*0.3%*		
UP	36,954	1,347	778	3,625	20,643	971	21,721	41,318	41,821	127,175	296,354	9%
Row Pct.	*12.5%*	*0.5%*	*0.3%*	*1.2%*	*7.0%*	*0.3%*	*7.3%*	*13.9%*	*14.1%*	*42.9%*		
Column Pct.	*6.8%*	*1.2%*	*0.7%*	*1.8%*	*8.3%*	*0.6%*	*2.0%*	*7.6%*	*14.0%*	*98.5%*		
Total	542,688	116,861	110,351	204,245	247,534	163,193	1,099,944	545,216	298,391	129,127	3,457,550	
(percent)	16%	3%	3%	6%	7%	5%	32%	16%	9%	4%		

over 40% of boat days occurring in the region are generated by boats kept in the other regions. For example, 52% of boat days in the northeast region are by boats kept within region, 30% by boats kept in the south-inland and central-inland regions, and 11% by boats kept in the southeast and central-east regions. The origin-destination matrix also shows a "south-to-north" pattern of movement by boats stored at nonwaterfront homes.

Model Evaluation

Similar to the evaluation of the distribution model for boats stored at marinas, the trip distribution model for boats stored at nonwaterfront homes is evaluated on its ability to distribute (1) boat days first to destination zones and (2) then to counties. The two steps are again evaluated separately. Table 29 provides the estimated sampling errors at the 90 percent confidence level for the distribution of boat days within 13 destination zones by storage regions. For example, there is a 3% sampling error (90% confidence level) associated with the estimate that 56% of boat days take place within the "20 miles" zone. This means that within the 90% confidence level, the population distribution of boat days occurring in the "within 20 miles" zone ranges from 53% to 59%.

Eighty percent of the sampling errors are 5% or less. The four largest sampling errors (11% to 13%) are for the central-east, northeast and southwest regions which have relatively small sample sizes (41 or fewer boats in the regions). For example, large sampling errors produce less reliable estimates for the percent (number) of boat days "within 20 miles" zone in the central-east region. With a 13% sampling error, the number of days that take place in the "within 20 miles" zone could range from 46,000 days to 76,000 days.

Table 29. Nonwaterfront Home Boat Days by Storage Region and Destination Zone: Sampling Errors at A 90% Confidence Interval.

Time-distance Destination Zones	South East	Central East	North East	North West	Central West	South West	South Inland	Central Inland	North Inland	U.P.	Total
Sampling Error at 90% Confidence Interval											
Within 20 miles	8.1%	13.0%	11.1%	8.8%	9.5%	12.8%	5.3%	6.1%	7.7%	8.2%	2.7%
21-60 miles	7.2%	7.8%	7.8%	7.7%	7.9%	11.0%	4.3%	4.8%	6.6%	0.0%	2.0%
61-90 miles	4.3%	9.9%	4.6%	2.9%	4.0%	6.7%	3.7%	5.1%	5.3%	6.1%	1.7%
91-120 miles	0.0%	6.8%	0.0%	2.1%	2.4%	0.0%	1.9%	3.3%	1.5%	6.1%	1.0%
121-150 miles	2.3%	5.7%	4.6%	2.1%	2.4%	4.0%	1.6%	3.8%	2.9%	1.8%	0.9%
151-180 miles	2.3%	4.0%	0.0%	2.1%	2.4%	4.0%	2.0%	2.5%	2.1%	2.5%	0.8%
181-210 miles	2.3%	4.0%	0.0%	2.1%	2.4%	6.7%	1.9%	3.1%	2.1%	1.8%	0.9%
211-240 miles	4.0%	0.0%	4.6%	2.1%	0.0%	5.5%	2.0%	2.9%	2.5%	1.8%	0.9%
241-270 miles	3.6%	4.0%	4.6%	2.1%	0.0%	0.0%	2.2%	2.7%	2.1%	0.0%	0.9%
271-300 miles	3.6%	0.0%	0.0%	0.0%	2.4%	4.0%	2.0%	1.1%	0.0%	0.0%	0.7%
301-360 miles	2.3%	4.0%	0.0%	0.0%	2.4%	0.0%	1.7%	2.5%	0.0%	0.0%	0.7%
361-420 miles	2.9%	0.0%	0.0%	0.0%	2.4%	0.0%	0.7%	1.9%	1.5%	0.0%	0.5%
Over 420 miles	1.7%	0.0%	0.0%	2.9%	2.4%	4.0%	1.0%	1.6%	3.2%	0.0%	0.6%
Distribution of Boat Days in Destination Zones											
Within 20 miles	44%	52%	92%	87%	70%	55%	54%	38%	59%	85%	56%
21-60 miles	25%	7%	5%	6%	9%	32%	20%	12%	15%	0%	16%
61-90 miles	8%	18%	2%	1%	8%	3%	7%	17%	11%	4%	8%
91-120 miles	0%	3%	0%	2%	0%	0%	2%	3%	0%	8%	2%
121-150 miles	2%	10%	0%	0%	1%	0%	1%	12%	1%	1%	3%
151-180 miles	1%	4%	0%	1%	0%	0%	5%	2%	0%	2%	2%
181-210 miles	1%	3%	0%	0%	1%	1%	1%	4%	0%	0%	1%
211-240 miles	7%	0%	1%	0%	0%	1%	3%	4%	1%	0%	3%
241-270 miles	3%	2%	0%	1%	0%	0%	3%	2%	1%	0%	2%
271-300 miles	2%	0%	0%	0%	0%	8%	1%	1%	0%	0%	1%
301-360 miles	2%	0%	0%	0%	3%	0%	2%	3%	0%	0%	2%
361-420 miles	4%	0%	0%	0%	1%	0%	0%	2%	0%	0%	1%
Over 420 miles	3%	0%	0%	1%	5%	1%	0%	1%	13%	0%	2%
No. of Boat Days (000')	*543*	*117*	*110*	*204*	*248*	*163*	*1,100*	*545*	*298*	*129*	*3,458*
No. of Cases	*98*	*40*	*35*	*78*	*69*	*41*	*230*	*145*	*112*	*92*	*940*

The second stage of the evaluation focuses on the estimates of the number of boat days in the counties. The model estimates of boat days in the counties are compared with the direct survey estimates. Again, two types of model estimates (A and B) are introduced by using two forms of model inputs: (1) survey based estimates of boat days generated by boats kept in counties (model estimates A), and (2) estimates of boat days in the storage counties produced by the trip generation model (model estimates B). In addition, the comparison between direct survey estimates and model estimates (A and B) is only at the regional level, not at the county level, because only two counties have sample sizes greater than 30.

The trip distribution model for boats stored at nonwaterfront homes estimates boat days in the regions reasonably well. With the exception of the southwest region, the regional percent differences between survey based estimates and model estimates (A) are 5% or less. The regional percent difference between the two estimates is about 11% in southwest region (Table 30). The 11% percent differences between the two estimates are acceptable within a 90% confidence level due to higher sampling errors (13%) in that region (Table 29).

In general, the differences between direct survey estimates and model estimates (B) are greater than the differences between direct survey estimates and model estimates (A). This is largely due to the compounding effects (errors) from the previous models. Except for the southwest region, the regional percent differences between survey base estimates and model estimates (B) are under 15%. The percent difference between the two estimates is 28% in the southwest region.

Table 30. Nonwaterfront Home Boat Days By County of Destination: A Comparision of Survey and Model Estimates.

Region/County	NUMBER OF BOAT DAYS Survey Estimate		Model Estimate			
			Model Input from 1994 Survey[a]		Model Input from Previous Model[b]	
		No. Cases	(A)	Percent Difference[c]	(B)	Percent Difference[c]
Regional Estimates						
South East	341,317	80	341,815	0%	387,953	14%
Central East	172,844	56	170,509	-1%	158,037	-9%
Northeast	182,887	73	187,923	3%	202,757	11%
Northwest	328,061	115	318,313	-3%	302,232	-8%
Central West	245,173	80	249,695	2%	237,231	-3%
Southwest	244,231	44	218,339	-11%	175,083	-28%
South Inland	934,027	161	976,695	5%	1,020,391	9%
Central Inland	233,442	55	235,086	1%	246,509	6%
North Inland	481,385	136	450,561	-6%	431,003	-10%
Upper Peninsula	294,184	140	308,613	5%	296,354	1%
STATE TOTAL	3,457,550	940	3,457,550		3,457,550	
County Level Estimates For Counties With Sample Sizes Larger Than 30 Boats						
Grand Traverse	92,339	31	79,035	-14%	72,242	-22%
Ottawa	142,555	46	150,281	5%	120,364	-16%
County Level Estimates For Counties With Sample Sizes Smaller Than 30 Boats						
Alcona	17,527	10	20,427	17%	25,688	47%
Alger	10,207	8	12,390	21%	14,175	39%
Allegan	87,389	13	66,569	-24%	78,189	-11%
Alpena	36,214	13	22,899	-37%	31,846	-12%
Antrim	38,628	8	27,632	-28%	30,232	-22%
Arenac	29,610	10	47,597	61%	45,564	54%
Baraga	17,303	9	17,047	-1%	14,778	-15%
Barry	114,462	17	36,829	-68%	38,964	-66%
Bay	50,675	27	52,823	4%	65,768	30%
Benzie	37,350	16	21,857	-41%	26,993	-28%
Berrien	63,576	15	85,342	34%	46,007	-28%
Branch	13,786	4	16,366	19%	28,809	109%
Calhoun	16,972	5	50,205	196%	41,908	147%
Cass	40,667	4	35,291	-13%	41,045	1%
Charlevoix	14,453	8	26,715	85%	35,537	146%
Cheboygan	45,950	15	34,558	-25%	37,818	-18%
Chippewa	3,182	3	21,101	563%	20,814	554%
Clare	43,940	7	48,769	11%	26,622	-39%
Clinton	8,409	2	16,005	90%	12,889	53%
Crawford	16,870	5	48,411	187%	39,439	134%
Delta	23,177	6	16,033	-31%	12,195	-47%
Dickinson	3,249	6	8,456	160%	9,511	193%
Eaton	1,771	1	18,562	948%	16,527	833%
Emmet	26,531	9	28,145	6%	29,866	13%
Genesee	52,830	13	63,348	20%	68,006	29%
Gladwin	40,210	8	21,594	-46%	28,165	-30%
Gogebic	4,776	3	13,564	184%	17,657	270%
Gratiot	35,159	3	31,890	-9%	7,090	-80%
Hillsdale	4,378	2	11,818	170%	18,547	324%
Houghton	13,076	11	30,242	131%	36,672	180%
Huron	72,267	19	35,368	-51%	35,713	-51%
Ingham	2,244	3	11,637	419%	32,708	1358%
Ionia	4,958	4	11,715	136%	17,148	246%
Iosco	30,950	17	31,156	1%	39,165	27%
Iron	55,071	22	40,156	-27%	49,755	-10%
Isabella	12,293	5	14,756	20%	9,105	-26%
Jackson	166,521	19	118,361	-29%	73,402	-56%

Table 31 (cont'd).

Region/County	NUMBER OF BOAT DAYS					
	Survey Estimate		Model Estimate			
			Model Input from 1994 Survey[a]		Model Input from Previous Model[b]	
		No. Cases	(A)	Percent Difference[c]	(B)	Percent Difference[c]
Kalamazoo	78,206	13	55,113	-30%	68,222	-13%
Kalkaska	20,526	4	26,063	27%	16,708	-19%
Kent	51,745	21	139,283	169%	153,637	197%
Keweenaw	70,132	16	21,427	-69%	22,439	-68%
Lake	4,014	3	27,598	588%	31,474	684%
Lapeer	22,597	7	10,805	-52%	15,987	-29%
Leelanau	11,819	12	22,298	89%	35,893	204%
Lenawee	46,384	7	33,010	-29%	33,220	-28%
Livingston	31,104	10	90,999	193%	111,396	258%
Luce	16,952	10	16,007	-6%	9,990	-41%
Mackinac	47,379	18	50,048	6%	25,939	-45%
Macomb	107,640	17	85,156	-21%	105,954	-2%
Manistee	87,101	24	79,634	-9%	28,757	-67%
Marquette	11,286	9	22,506	99%	12,193	8%
Mason	19,841	7	32,998	66%	42,712	115%
Mecosta	13,656	9	17,963	32%	25,217	85%
Menominee	1,826	4	6,106	234%	11,981	556%
Midland	76,662	7	40,013	-48%	16,999	-78%
Missaukee	30,341	5	11,273	-63%	10,626	-65%
Monroe	69,820	24	49,356	-29%	41,359	-41%
Montcalm	82,902	12	53,072	-36%	38,049	-54%
Montmorency	17,600	6	8,939	-49%	11,827	-33%
Muskegon	93,105	28	83,583	-10%	90,008	-3%
Newaygo	54,020	18	83,755	55%	60,774	13%
Oakland	181,090	26	201,470	11%	246,737	36%
Oceana	9,513	6	15,831	66%	26,859	182%
Ogemaw	19,473	6	34,220	76%	38,191	96%
Ontonagon	8,064	7	16,443	104%	19,863	146%
Osceola	10,368	5	9,455	-9%	15,631	51%
Oscoda	14,208	8	23,407	65%	30,988	118%
Otsego	16,035	5	24,141	51%	24,803	55%
Presque Isle	22,636	8	31,286	38%	22,677	0%
Roscommon	126,921	26	40,856	-68%	47,087	-63%
Saginaw	10,937	8	12,615	15%	38,778	255%
Saint Joseph	7,152	4	11,349	59%	35,276	393%
Sanilac	6,982	1	23,812	241%	19,873	185%
Schoolcraft	8,503	8	17,086	101%	18,394	116%
Shiawassee	5,582	2	3,740	-33%	11,270	102%
St Clair	48,935	14	52,943	8%	67,620	38%
Tuscola	42,921	9	58,506	36%	36,683	-15%
Van Buren	93,266	16	66,427	-29%	50,887	-45%
Washtenaw	98,658	17	123,527	25%	91,180	-8%
Wayne	114,922	25	154,360	34%	173,021	51%
Wexford	53,204	21	24,116	-55%	23,452	-56%

a. The model input, number of boat days in the storage counties, are generated directly from the 1994 Michigan Boating Survey

b. The model input, number of boat days in the storage counties, are generated from previous boat days generation model

c. Percent differences are calculated as (model estimate - survey estimate) / survey estimate.

Boat Days In Counties By Boat Storage Segments

This section presents and evaluates the overall results of trip distribution models which are used to estimate the number of boat days in the counties by boats in different storage segments. The summation of "overall trip distribution models" includes the trip generation model, trip distribution model for boats stored at marinas in the coastal counties, trip distribution model for boats stored at nonwaterfront homes and trip distribution scheme for boats kept at marinas in the inland counties, waterfront homes and second homes[33].

Results

Table 31 summarizes the predictions of the overall trip distribution models. The total number of boat days in counties ranges from 24,200 days in Gratiot county to 727,800 days in Oakland county. Fifteen percent of the state's total boat days occur in four southeast counties. Conversely, nine north Upper Peninsula counties host only 5% of state's total boat days. About 18% of boat days take place in the northeast and northwest regions, 29% in the south-inland region, 19% in the north-inland and south Upper Peninsula regions, 9% in the central-west and southwest regions, and the remaining 5% in the central-east region.

The spatial distribution of boating destinations vary across storage segments. Over forty percent of the boat days generated by boats stored at marinas take place in the southeast region, and another 22% of days occur in the northwest (14%) and central-west

[33] As mentioned in the method chapter, all the boat days generated by boats stored at marinas in inland counties, second homes and waterfront homes are allocated to their storage counties, assuming that all the boat days take place within storage counties.

Table 31. Number of Boat Days by Storage Segment and Destination County.

Boat days (000's)	BOAT STORAGE SEGMENTS												Total	
	Marina			Second Home			Waterfront Home			Nonwaterfront Home				
DESTINATION COUNTY/REGION	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %
Macomb	269.5	14.6%	44.3%	15.8	0.5%	2.6%	217.7	6.0%	35.8%	106.0	3.1%	17.4%	608.9	5.0%
Monroe	143.0	7.7%	60.6%	8.8	0.3%	3.7%	42.8	1.2%	18.1%	41.4	1.2%	17.5%	235.9	1.9%
St Clair	158.8	8.6%	46.2%	57.6	1.7%	16.8%	59.7	1.6%	17.4%	67.6	2.0%	19.7%	343.8	2.8%
Wayne	194.4	10.5%	27.7%	30.7	0.9%	4.4%	304.5	8.4%	43.3%	173.0	5.0%	24.6%	702.6	5.7%
SOUTHEAST	***765.6***	***41.5%***	***40.5%***	***112.9***	***3.4%***	***6.0%***	***624.7***	***17.2%***	***33.0%***	***388.0***	***11.2%***	***20.5%***	***1,891.1***	***15.4%***
Bay	87.9	4.8%	51.3%	4.3	0.1%	2.5%	13.4	0.4%	7.8%	65.8	1.9%	38.4%	171.4	1.4%
Huron	45.2	2.5%	29.8%	67.0	2.0%	44.1%	4.0	0.1%	2.7%	35.7	1.0%	23.5%	152.0	1.2%
Saginaw	2.7	0.1%	4.2%	2.7	0.1%	4.1%	20.9	0.6%	32.1%	38.8	1.1%	59.6%	65.0	0.5%
Sanilac	27.0	1.5%	28.4%	45.7	1.4%	48.0%	2.7	0.1%	2.8%	19.9	0.6%	20.8%	95.3	0.8%
Tuscola	13.8	0.7%	21.0%	9.8	0.3%	14.8%	5.7	0.2%	8.7%	36.7	1.1%	55.6%	66.0	0.5%
CENTRAL EAST	***176.7***	***9.6%***	***32.1%***	***129.5***	***3.9%***	***23.6%***	***46.8***	***1.3%***	***8.5%***	***196.8***	***5.7%***	***35.8%***	***549.8***	***4.5%***
Alcona	4.4	0.2%	3.0%	97.3	2.9%	67.4%	17.0	0.5%	11.8%	25.7	0.7%	17.8%	144.4	1.2%
Alpena	7.5	0.4%	7.4%	31.4	0.9%	30.9%	30.9	0.9%	30.4%	31.8	0.9%	31.3%	101.7	0.8%
Arenac	24.7	1.3%	17.7%	41.9	1.2%	29.9%	27.8	0.8%	19.9%	45.6	1.3%	32.5%	140.0	1.1%
Cheboygan	24.4	1.3%	13.5%	83.9	2.5%	46.4%	34.7	1.0%	19.2%	37.8	1.1%	20.9%	180.8	1.5%
Iosco	29.3	1.6%	13.3%	115.3	3.4%	52.2%	37.0	1.0%	16.8%	39.2	1.1%	17.7%	220.8	1.8%
Presque Isle	10.4	0.6%	9.9%	52.9	1.6%	50.4%	18.8	0.5%	18.0%	22.7	0.7%	21.6%	104.8	0.9%
NORTH EAST	***100.7***	***5.5%***	***11.3%***	***422.7***	***12.6%***	***47.4%***	***166.3***	***4.6%***	***18.6%***	***202.8***	***5.9%***	***22.7%***	***892.6***	***7.3%***
Antrim	9.2	0.5%	5.9%	80.1	2.4%	51.1%	37.3	1.0%	23.8%	30.2	0.9%	19.3%	156.8	1.3%
Benzie	27.8	1.5%	20.7%	53.6	1.6%	40.0%	25.8	0.7%	19.2%	27.0	0.8%	20.1%	134.2	1.1%
Charlevoix	65.5	3.5%	32.7%	66.1	2.0%	33.0%	33.0	0.9%	16.5%	35.5	1.0%	17.8%	200.1	1.6%
Emmet	29.1	1.6%	17.1%	74.7	2.2%	44.0%	36.3	1.0%	21.3%	29.9	0.9%	17.6%	170.0	1.4%
Grand Traverse	15.3	0.8%	6.5%	56.2	1.7%	23.8%	92.6	2.6%	39.2%	72.2	2.1%	30.6%	236.3	1.9%
Leelanau	40.5	2.2%	22.1%	71.2	2.1%	38.7%	36.1	1.0%	19.7%	35.9	1.0%	19.5%	183.7	1.5%
Manistee	39.7	2.2%	26.6%	54.5	1.6%	36.5%	26.3	0.7%	17.6%	28.8	0.8%	19.3%	149.3	1.2%
Mason	26.8	1.5%	17.7%	51.9	1.5%	34.3%	29.8	0.8%	19.7%	42.7	1.2%	28.2%	151.3	1.2%
NORTHWEST	***253.8***	***13.8%***	***18.4%***	***508.3***	***15.1%***	***36.8%***	***317.2***	***8.7%***	***23.0%***	***302.2***	***8.7%***	***21.9%***	***1,381.6***	***11.2%***
Muskegon	50.9	2.8%	26.4%	22.7	0.7%	11.8%	29.1	0.8%	15.1%	90.0	2.6%	46.7%	192.7	1.6%
Oceana	8.8	0.5%	8.1%	67.9	2.0%	62.9%	4.4	0.1%	4.1%	26.9	0.8%	24.9%	108.0	0.9%
Ottawa	81.0	4.4%	28.9%	33.5	1.0%	11.9%	45.3	1.2%	16.2%	120.4	3.5%	43.0%	280.1	2.3%
CENTRAL WEST	***140.7***	***7.6%***	***24.2%***	***124.0***	***3.7%***	***21.4%***	***78.9***	***2.2%***	***13.6%***	***237.2***	***6.9%***	***40.8%***	***580.8***	***4.7%***
Allegan	25.5	1.4%	13.9%	22.7	0.7%	12.3%	57.7	1.6%	31.4%	78.2	2.3%	42.5%	184.1	1.5%
Berrien	45.0	2.4%	21.8%	36.9	1.1%	17.9%	78.5	2.2%	38.0%	46.0	1.3%	22.3%	206.4	1.7%
Van Buren	25.0	1.4%	16.7%	29.1	0.9%	19.4%	45.0	1.2%	30.0%	50.9	1.5%	33.9%	150.0	1.2%
SOUTHWEST	***95.5***	***5.2%***	***17.7%***	***88.7***	***2.6%***	***16.4%***	***181.2***	***5.0%***	***33.5%***	***175.1***	***5.1%***	***32.4%***	***540.4***	***4.4%***

Table 31 (cont'd).

Boat days (000's)	BOAT STORAGE SEGMENTS												Total	
	Marina			Second Home			Waterfront Home			Nonwaterfront Home				
DESTINATION COUNTY/REGION	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %
Barry	9.4	0.5%	6.9%	51.3	1.5%	37.9%	35.7	1.0%	26.4%	39.0	1.1%	28.8%	135.3	1.1%
Branch	7.5	0.4%	6.2%	57.8	1.7%	47.5%	27.5	0.8%	22.6%	28.8	0.8%	23.7%	121.7	1.0%
Calhoun	3.0	0.2%	3.4%	0.2	0.0%	0.2%	44.8	1.2%	49.8%	41.9	1.2%	46.6%	90.0	0.7%
Cass	11.4	0.6%	7.2%	70.5	2.1%	44.2%	36.5	1.0%	22.9%	41.0	1.2%	25.7%	159.5	1.3%
Clinton	0.1	0.0%	0.1%	1.0	0.0%	2.6%	25.9	0.7%	65.0%	12.9	0.4%	32.3%	39.9	0.3%
Eaton	0.1	0.0%	0.1%	3.3	0.1%	5.9%	36.1	1.0%	64.5%	16.5	0.5%	29.5%	55.9	0.5%
Genesee	1.7	0.1%	0.7%	17.7	0.5%	7.6%	143.7	4.0%	62.2%	68.0	2.0%	29.4%	231.1	1.9%
Gratiot	0.2	0.0%	0.9%	2.4	0.1%	9.8%	14.5	0.4%	60.0%	7.1	0.2%	29.3%	24.2	0.2%
Hillsdale	1.7	0.1%	2.1%	40.6	1.2%	49.6%	21.0	0.6%	25.6%	18.5	0.5%	22.7%	81.9	0.7%
Ingham	0.0	0.0%	0.0%	7.7	0.2%	6.8%	72.9	2.0%	64.3%	32.7	0.9%	28.8%	113.4	0.9%
Ionia	0.4	0.0%	0.9%	8.7	0.3%	18.6%	20.6	0.6%	43.9%	17.1	0.5%	36.6%	46.9	0.4%
Isabella	0.3	0.0%	0.6%	20.9	0.6%	43.4%	17.8	0.5%	37.1%	9.1	0.3%	18.9%	48.1	0.4%
Jackson	10.6	0.6%	5.5%	41.3	1.2%	21.4%	67.4	1.9%	35.0%	73.4	2.1%	38.1%	192.6	1.6%
Kalamazoo	8.0	0.4%	4.7%	13.7	0.4%	8.0%	82.0	2.3%	47.7%	68.2	2.0%	39.7%	171.9	1.4%
Kent	7.2	0.4%	1.9%	30.5	0.9%	8.0%	187.2	5.2%	49.5%	153.6	4.4%	40.6%	378.5	3.1%
Lapeer	1.8	0.1%	2.9%	16.6	0.5%	26.5%	28.4	0.8%	45.2%	16.0	0.5%	25.4%	62.9	0.5%
Lenawee	2.3	0.1%	1.9%	48.7	1.5%	39.8%	38.3	1.1%	31.2%	33.2	1.0%	27.1%	122.6	1.0%
Livingston	13.9	0.8%	6.0%	36.8	1.1%	15.9%	69.6	1.9%	30.1%	111.4	3.2%	48.1%	231.7	1.9%
Midland	0.4	0.0%	0.6%	9.3	0.3%	13.9%	40.5	1.1%	60.2%	17.0	0.5%	25.3%	67.2	0.5%
Montcalm	5.3	0.3%	3.9%	64.3	1.9%	48.0%	26.3	0.7%	19.7%	38.0	1.1%	28.4%	133.9	1.1%
Oakland	49.9	2.7%	6.9%	57.2	1.7%	7.9%	373.9	10.3%	51.4%	246.7	7.1%	33.9%	727.8	5.9%
Shiawassee	9.1	0.5%	12.6%	2.6	0.1%	3.6%	25.5	0.7%	35.2%	35.3	1.0%	48.6%	72.6	0.6%
St Joseph	0.1	0.0%	0.1%	33.2	1.0%	41.3%	35.8	1.0%	44.5%	11.3	0.3%	14.0%	80.3	0.7%
Washtenaw	7.6	0.4%	4.0%	20.9	0.6%	11.0%	70.4	1.9%	37.0%	91.2	2.6%	47.9%	190.2	1.5%
SOUTH INLAND	***152.1***	***8.2%***	***4.2%***	***657.4***	***19.6%***	***18.4%***	***1,542.4***	***42.5%***	***43.1%***	***1,228.1***	***35.5%***	***34.3%***	***3,580.0***	***29.1%***
Clare	2.4	0.1%	1.6%	91.7	2.7%	60.5%	30.9	0.9%	20.4%	26.6	0.8%	17.6%	151.7	1.2%
Crawford	0.6	0.0%	0.5%	43.3	1.3%	41.2%	21.7	0.6%	20.7%	39.4	1.1%	37.6%	105.0	0.9%
Gladwin	2.0	0.1%	1.5%	60.8	1.8%	47.8%	36.3	1.0%	28.5%	28.2	0.8%	22.1%	127.2	1.0%
Kalkaska	1.7	0.1%	2.2%	38.4	1.1%	51.0%	18.5	0.5%	24.6%	16.7	0.5%	22.2%	75.3	0.6%
Lake	0.9	0.0%	0.7%	82.6	2.5%	63.2%	15.7	0.4%	12.0%	31.5	0.9%	24.1%	130.7	1.1%
Mecosta	4.9	0.3%	4.9%	36.2	1.1%	36.0%	34.4	0.9%	34.1%	25.2	0.7%	25.0%	100.7	0.8%
Missaukee	1.1	0.1%	2.1%	26.7	0.8%	49.5%	15.5	0.4%	28.7%	10.6	0.3%	19.7%	54.0	0.4%
Montmorency	5.1	0.3%	5.9%	53.9	1.6%	62.9%	14.9	0.4%	17.4%	11.8	0.3%	13.8%	85.8	0.7%
Newaygo	5.5	0.3%	3.2%	56.0	1.7%	33.2%	46.5	1.3%	27.5%	60.8	1.8%	36.0%	168.7	1.4%

Table 31 (cont'd).

Boat days (000's)	BOAT STORAGE SEGMENTS												Total	
	Marina			Second Home			Waterfront Home			Nonwaterfront Home				
DESTINATION COUNTY/REGION	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %	Row %	No. of Boat Days	Col. %
Ogemaw	2.4	0.1%	1.9%	62.9	1.9%	49.2%	24.3	0.7%	19.0%	38.2	1.1%	29.9%	127.7	1.0%
Osceola	0.5	0.0%	0.7%	36.8	1.1%	52.8%	16.8	0.5%	24.0%	15.6	0.5%	22.4%	69.7	0.6%
Oscoda	0.6	0.0%	0.6%	50.0	1.5%	52.3%	14.0	0.4%	14.6%	31.0	0.9%	32.4%	95.6	0.8%
Otsego	2.8	0.2%	3.2%	41.1	1.2%	45.8%	20.9	0.6%	23.4%	24.8	0.7%	27.7%	89.7	0.7%
Roscommon	14.7	0.8%	6.4%	117.1	3.5%	50.9%	51.3	1.4%	22.3%	47.1	1.4%	20.5%	230.1	1.9%
Wexford	1.3	0.1%	1.6%	24.0	0.7%	29.4%	33.0	0.9%	40.3%	23.5	0.7%	28.7%	81.7	0.7%
NORTH INLAND	***46.4***	***2.5%***	***2.7%***	***821.6***	***24.4%***	***48.5%***	***394.6***	***10.9%***	***23.3%***	***431.0***	***12.5%***	***25.4%***	***1,693.6***	***13.8%***
Delta	7.1	0.4%	6.0%	59.9	1.8%	50.4%	25.9	0.7%	21.8%	25.9	0.8%	21.8%	118.8	1.0%
Dickinson	-	0.0%	0.0%	42.0	1.2%	57.7%	18.7	0.5%	25.8%	12.0	0.3%	16.5%	72.7	0.6%
Iron	-	0.0%	0.0%	64.2	1.9%	69.2%	13.8	0.4%	14.9%	14.8	0.4%	15.9%	92.8	0.8%
Mackinac	22.6	1.2%	12.8%	100.3	3.0%	56.7%	17.3	0.5%	9.8%	36.7	1.1%	20.7%	176.8	1.4%
Menominee	6.3	0.3%	8.6%	42.9	1.3%	58.0%	14.7	0.4%	19.9%	10.0	0.3%	13.5%	73.9	0.6%
Schoolcraft	1.5	0.1%	2.0%	44.3	1.3%	58.0%	10.6	0.3%	14.0%	19.9	0.6%	26.0%	76.3	0.6%
SOUTH U.P.	***37.5***	***2.0%***	***6.1%***	***353.6***	***10.5%***	***57.8%***	***101.1***	***2.8%***	***16.5%***	***119.2***	***3.4%***	***19.5%***	***611.4***	***5.0%***
Alger	2.5	0.1%	6.3%	12.9	0.4%	32.4%	12.2	0.3%	30.7%	12.2	0.4%	30.6%	39.8	0.3%
Baraga	10.1	0.5%	29.3%	7.9	0.2%	22.9%	7.1	0.2%	20.4%	9.5	0.3%	27.4%	34.7	0.3%
Chippewa	30.1	1.6%	20.4%	33.3	1.0%	22.6%	34.1	0.9%	23.1%	49.8	1.4%	33.8%	147.2	1.2%
Gogebic	2.7	0.1%	4.7%	17.6	0.5%	30.4%	19.2	0.5%	33.2%	18.4	0.5%	31.7%	57.9	0.5%
Houghton	11.1	0.6%	17.1%	16.8	0.5%	25.8%	22.9	0.6%	35.3%	14.2	0.4%	21.8%	65.0	0.5%
Keweenaw	7.0	0.4%	17.9%	8.9	0.3%	22.8%	2.4	0.1%	6.2%	20.8	0.6%	53.1%	39.2	0.3%
Luce	0.2	0.0%	0.5%	7.7	0.2%	21.6%	10.1	0.3%	28.4%	17.7	0.5%	49.4%	35.7	0.3%
Marquette	10.2	0.6%	8.8%	28.4	0.8%	24.5%	54.8	1.5%	47.3%	22.4	0.6%	19.4%	115.8	0.9%
Ontonagon	2.6	0.1%	8.1%	8.5	0.3%	25.9%	9.4	0.3%	28.8%	12.2	0.4%	37.2%	32.8	0.3%
NORTH U.P.	***76.6***	***4.2%***	***13.5%***	***142.0***	***4.2%***	***25.0%***	***172.3***	***4.8%***	***30.3%***	***177.1***	***5.1%***	***31.2%***	***568.1***	***4.6%***
TOTAL	**1,845.6**	**100%**	**15.0%**	**3,360.8**	**100%**	**27.3%**	**3,625.4**	**100%**	**29.5%**	**3,457.6**	**100%**	**28.1%**	**12,289.4**	**100%**

note: Because cases with missing storage variables are excluded from the (survey based) estimates of boats in different storage segments by storage regions (Table 13) that are used in the allocation models, the number of boats estimated by storage allocation models is less than the number of registered active craft (555,000 boats). Because the estimates by trip distribution model are based on the estimates derived from the generation and allocation models, the model estimated number of boat days is lower than total number of boat days (13.4 million days) reported in 1994 Recreational Boating Survey (Stynes et al., 1995).

regions (8%). Fifteen percent (269,500 days) of the boat days by boats stored at marinas take place in Macomb county.

Approximately 35 percent of boat days generated by boats stored at second homes occur in the north-inland and south Upper Peninsula regions, and only 3.4% at the southeast region. Cheboygan, Roscommon, and Mackinac counties individually host over 100,000 boat days.

Almost 60 percent of boat days generated by boats stored at waterfront homes take place in the south-inland (43%) and southeast regions (17%), and only 2.8% in the south Upper Peninsula region. Counties, such as Oakland, Wayne and Macomb, with high population density and fair amounts of water resources receive more than 200,000 days each.

Almost half of all boat days generated by boats stored at nonwaterfront homes occur in the south-inland and southeast regions, 18% in the central-east, central-west and southwest regions. Wayne (246,700 days), Kent (173,000 days), and Oakland (153,600 days) counties host over a half million boat days by boats stored at nonwaterfront homes.

The regions vary significantly in the amount of boating use by boats in different storage segments. For example, almost 21 million boat days take place in the southeast region. The greatest number of days are by boats stored at marinas (41%) and waterfront homes (33%). In comparison, there are 611,400 days of boating in the south UP region of which 58% is by boats stored at second homes. In the north UP region, almost two-thirds (62%) of the 568,000 days are by boats stored at waterfront homes (30%) and nonwaterfront homes (31%).

Table 32 provides an origin (storage location) - destination (use location) matrix. The matrix reveals the amount and proportion of boat days in destination regions by boats kept in the different origin regions. The matrix also shows the number and proportion of days generated by boats kept in regions that take place in different destination regions. A lower percentage of boat days generated by boats kept in southern Michigan -- southeast, central-east, central-west and south-inland regions -- occur within these regions. About 87% of boat days by boats kept in the south-inland region remain within the region, 13% are exported to the other regions. Comparatively, almost all (over 95%) of boat days by boats kept in the Northern Michigan remain within the region. The origin-destination matrix clearly shows the "south-to-north" travel patterns for Michigan boating use. An origin (storage location)- destination (use location) matrix broken down by storage segment is included in the appendix E. It shows how boats in different storage segments contribute to the origin-destination flows.

Model Evaluation

The predictions of overall trip distribution models are evaluated by comparing model estimates with direct survey estimates. The percent differences between direct survey estimates and model estimates range from 2% in Grand Traverse county to 4442% in Ingham county. Only 4 boats were sampled in Ingham county, so the survey based estimates is quite unreliable. Most counties with over 100% difference have sample sizes of less than 15 boats. Usable responses to the 1994 Michigan Boating Survey were less

Table 32. Number of Boat Days by Storage Region and Destination Region.

Boat Days	STORAGE REGIONS										Total	
Destination Regions	South East	Central East	North East	North West	Central West	South West	Inland South	Inland North	UP South	UP North		(pct.)
Southeast	1,790,956	12,504	2,218	2,801	3,847	2,018	75,827	260	242	470	1,891,143	15%
Row Pct.	*95%*	*1%*	*0%*	*0%*	*0%*	*0%*	*4%*	*0%*	*0%*	*0%*		
Column pct.	*86%*	*2%*	*0%*	*0%*	*1%*	*0%*	*2%*	*0%*	*0%*	*0%*		
Central East	23,375	463,046	1,275	1,117	1,129	2,484	55,447	1,760	46	83	549,760	4%
Row Pct.	*4%*	*84%*	*0%*	*0%*	*0%*	*0%*	*10%*	*0%*	*0%*	*0%*		
Column pct.	*1%*	*79%*	*0%*	*0%*	*0%*	*0%*	*1%*	*0%*	*0%*	*0%*		
Northeast	17,559	31,262	776,308	3,802	4,875	1,908	47,768	8,042	328	699	892,551	7%
Row Pct.	*2%*	*4%*	*87%*	*0%*	*1%*	*0%*	*5%*	*1%*	*0%*	*0%*		
Column pct.	*1%*	*5%*	*98%*	*0%*	*1%*	*0%*	*1%*	*1%*	*0%*	*0%*		
Northwest	29,400	17,027	3,923	1,230,927	12,060	8,522	62,770	15,360	743	835	1,381,567	11%
Row Pct.	*2%*	*1%*	*0%*	*89%*	*1%*	*1%*	*5%*	*1%*	*0%*	*0%*		
Column pct.	*1%*	*3%*	*0%*	*98%*	*2%*	*2%*	*2%*	*1%*	*0%*	*0%*		
Central West	11,969	3,587	739	2,692	514,632	6,237	34,184	6,544	77	150	580,810	5%
Row Pct.	*2%*	*1%*	*0%*	*0%*	*89%*	*1%*	*6%*	*1%*	*0%*	*0%*		
Column pct.	*1%*	*1%*	*0%*	*0%*	*86%*	*1%*	*1%*	*0%*	*0%*	*0%*		
Southwest	6,788	2,481	514	812	12,176	465,439	51,794	271	56	108	540,438	4%
Row Pct.	*1%*	*0%*	*0%*	*0%*	*2%*	*86%*	*10%*	*0%*	*0%*	*0%*		
Column pct.	*0%*	*0%*	*0%*	*0%*	*2%*	*89%*	*1%*	*0%*	*0%*	*0%*		
Inland South	114,073	12,180	100	858	13,324	28,181	3,408,004	3,268	0	0	3,579,987	29%
Row Pct.	*3%*	*0%*	*0%*	*0%*	*0%*	*1%*	*95%*	*0%*	*0%*	*0%*		
Column pct.	*5%*	*2%*	*0%*	*0%*	*2%*	*5%*	*87%*	*0%*	*0%*	*0%*		
Inland North	43,278	30,582	3,049	5,686	12,843	5,609	108,480	1,483,641	272	139	1,693,578	14%
Row Pct.	*3%*	*2%*	*0%*	*0%*	*1%*	*0%*	*6%*	*88%*	*0%*	*0%*		
Column pct.	*2%*	*5%*	*0%*	*0%*	*2%*	*1%*	*3%*	*95%*	*0%*	*0%*		
UP South	15,155	8,433	1,373	2,232	9,711	953	23,929	6,049	538,505	5,066	611,407	5%
Row Pct.	*2%*	*1%*	*0%*	*0%*	*2%*	*0%*	*4%*	*1%*	*88%*	*1%*		
Column pct.	*1%*	*1%*	*0%*	*0%*	*2%*	*0%*	*1%*	*0%*	*99%*	*1%*		
UP North	32,833	7,231	851	3,227	13,412	1,200	30,396	35,771	4,197	439,006	568,124	5%
Row Pct.	*6%*	*1%*	*0%*	*1%*	*2%*	*0%*	*5%*	*6%*	*1%*	*77%*		
Column pct.	*2%*	*1%*	*0%*	*0%*	*2%*	*0%*	*1%*	*2%*	*1%*	*98%*		
Total	2,085,385	588,333	790,348	1,254,154	598,009	522,551	3,898,599	1,560,967	544,466	446,555	12,289,366	
(percent)	17%	5%	6%	10%	5%	4%	32%	13%	4%	4%		

than 30 for 42 out of the 83 counties[34]. Only 12 counties had questionnaires representing more than 100 boats. Sample sizes are much smaller for individual storage segments at the county level. The 41 (destination) counties with sample size greater than 30 boats provide a firmer basis for evaluating trip distribution model (Table 33).

With the exception of the central-east region and northeast region, the differences between direct survey estimates and model estimates are less than 12%. The percent differences between the two estimates are 21% in central-east region and 23% in the northeast region. In the northeast region, there is a major difference in estimates of boat days by boats kept in the second homes. The trip distribution models estimate more boat days by boats at second homes compared to the survey based estimate. This may suggest that the boats stored at second homes are used less frequently in the northeast region, or the second home owners have less propensity to use or store their boats within the region.

For the 41 counties with sample sizes more than 30 boats, the percent difference ranges from 1% to 235%. The percent difference is less than 10% for 13 counties, and more than 50% for seven counties (Iosco, Oceana, Menominee, Houghton, and Mackinac, Barry and Kent counties). For the Iosco, Oceana, Menominee, Houghton, and Mackinac counties, differences between the two estimates are largely attributable to differences in the estimates of boat days by boats stored at second homes. Most of the differences between the estimates for Barry and Kent counties are caused by the differences in estimates for boats stored at waterfront and nonwaterfront homes. The percent difference only indicates the discrepancy between the model estimate and direct survey estimate. It

[34] The boats select the county as one of their boating destinations. 1994 Michigan Boating Survey questionnaire allowed respondents to indicate one to three counties as their most frequent boating destinations.

Table 33. Boat Days by County of Destination: A Comparison of Survey and Model Estimates.

Boat days (000') Destination County/Region	Distribution Model	Survey Estimates[a]			Difference[b] Marina	Second Home	Waterfront Home	Non-waterfront Home	All	Percent difference[c]
Regional Estimates										
Southeast	1,891.1	2,152.7	(	543)	-57.8	-238.4	-12.1	46.6	-261.6	-12%
Central East	549.8	454.3	(	278)	37.4	36.2	8.9	13.0	95.5	21%
Northeast	892.6	723.3	(	400)	15.3	116.2	17.8	19.9	169.3	23%
Northwest	1,381.6	1,354.6	(	711)	18.9	27.6	6.3	-25.8	26.9	2%
Central West	580.8	551.2	(	335)	-5.2	36.1	6.7	-7.9	29.6	5%
Southwest	540.4	598.2	(	221)	-1.5	-8.1	20.9	-69.1	-57.8	-10%
South Inland	3,580.0	3,541.4	(	462)	-0.1	32.5	-65.5	71.6	38.6	1%
North Inland	1,693.6	1,682.6	(	351)	0.1	59.2	2.1	-50.4	11.0	1%
South U.P.	611.4	657.4	(	296)	-5.0	-14.2	-41.5	14.6	-46.0	-7%
North U.P.	568.1	573.6	(	311)	-2.2	-47.1	56.3	-12.5	-5.5	-1%
TOTAL	12,289.4	12,289.4	(	3908)						
County Level Estimates For Counties With Sample Sizes Larger Than 30 Boats										
Alcona	*144.4*	*103.5*	(	*40*)	*2.9*	*23.4*	*6.5*	*8.2*	*40.9*	*40%*
Allegan	*184.1*	*256.8*	(	*86*)	*-6.7*	*-21.9*	*-34.9*	*-9.2*	*-72.7*	*-28%*
Alpena	*101.7*	*108.5*	(	*41*)	*5.4*	*-17.4*	*9.5*	*-4.4*	*-6.8*	*-6%*
Antrim	*156.8*	*203.8*	(	*69*)	*-15.9*	*-6.4*	*-16.3*	*-8.4*	*-47.0*	*-23%*
Arenac	*140.0*	*98.9*	(	*65*)	*-9.7*	*18.4*	*16.5*	*16.0*	*41.1*	*42%*
Barry	*135.3*	*372.9*	(	*41*)	*-7.0*	*-32.2*	*-122.9*	*-75.5*	*-237.6*	*-64%*
Bay	*171.4*	*166.7*	(	*146*)	*-10.8*	*-1.2*	*1.6*	*15.1*	*4.6*	*3%*
Benzie	*134.2*	*144.0*	(	*54*)	*8.0*	*3.0*	*-10.4*	*-10.4*	*-9.8*	*-7%*
Berrien	*206.4*	*158.7*	(	*71*)	*8.4*	*23.7*	*33.1*	*-17.6*	*47.7*	*30%*
Charlevoix	*200.1*	*182.9*	(	*129*)	*25.4*	*-39.7*	*10.5*	*21.1*	*17.2*	*9%*
Cheboygan	*180.8*	*211.0*	(	*126*)	*-4.8*	*-3.8*	*-13.4*	*-8.1*	*-30.2*	*-14%*
Chippewa	*147.2*	*206.7*	(	*85*)	*11.1*	*-61.5*	*-3.8*	*-5.3*	*-59.5*	*-29%*
Delta	*118.8*	*114.4*	(	*58*)	*0.7*	*34.0*	*-8.8*	*-21.4*	*4.5*	*4%*
Emmet	*170.0*	*124.0*	(	*111*)	*-14.7*	*30.8*	*26.7*	*3.3*	*46.1*	*37%*
Grand Traverse	*236.3*	*232.7*	(	*109*)	*-2.1*	*23.3*	*2.6*	*-20.1*	*3.7*	*2%*
Houghton	65.0	39.0	(	46)	3.5	12.9	5.7	4.0	26.0	67%
Huron	152.0	155.5	(	66)	25.8	4.5	2.8	-36.6	-3.4	-2%
Iosco	220.8	129.1	(	86)	16.9	58.7	7.8	8.2	91.7	71%
Jackson	192.6	349.8	(	39)	0.3	-11.2	-53.2	-93.1	-157.2	-45%
Kalamazoo	171.9	197.6	(	32)	-11.3	-18.6	14.2	-10.0	-25.6	-13%
Kent	378.5	158.7	(	36)	7.2	7.6	103.1	101.9	219.8	138%
Leelanau	*183.7*	*158.0*	(	*133*)	*2.2*	*18.3*	*-18.9*	*24.1*	*25.7*	*16%*
Mackinac	176.8	388.0	(	169)	-10.7	-138.8	-85.3	23.6	-211.2	-54%
Macomb	*608.9*	*715.8*	(	*161*)	*64.7*	*-91.7*	*-78.2*	*-1.7*	*-106.9*	*-15%*
Manistee	149.3	164.1	(	74)	-7.1	51.0	-0.4	-58.3	-14.8	-9%
Marquette	115.8	168.8	(	67)	-11.2	-11.9	17.8	-47.7	-53.0	-31%
Mason	151.3	145.3	(	32)	23.1	-52.6	12.5	22.9	6.0	4%
Mecosta	100.7	159.5	(	34)	-1.4	-83.7	14.8	11.6	-58.7	-37%
Menominee	73.9	22.1	(	32)	3.5	42.9	12.5	-7.0	51.9	235%
Monroe	*235.9*	*232.0*	(	*77*)	*33.8*	*-26.9*	*25.4*	*-28.5*	*3.9*	*2%*
Muskegon	*192.7*	*232.7*	(	*130*)	*-34.0*	*1.8*	*-4.6*	*-3.1*	*-40.0*	*-17%*
Newaygo	168.7	245.0	(	53)	-7.2	-68.3	-7.5	6.8	-76.3	-31%
Oakland	727.8	626.7	(	60)	3.1	4.6	27.8	65.6	101.1	16%
Oceana	*108.0*	*58.8*	(	*38*)	*3.2*	*30.7*	*-2.1*	*17.3*	*49.2*	*84%*
Ottawa	280.1	259.7	(	167)	25.5	3.6	13.5	-22.2	20.4	8%
Presque Isle	104.8	72.2	(	42)	4.6	37.0	-9.0	0.0	32.6	45%
Roscommon	230.1	332.9	(	75)	-8.1	25.6	-40.4	-79.8	-102.8	-31%
St Clair	*343.8*	*547.7*	(	*151*)	*-79.3*	*-71.0*	*-72.3*	*18.7*	*-203.9*	*-37%*
Van Buren	*150.0*	*182.8*	(	*64*)	*-3.2*	*-10.0*	*22.7*	*-42.4*	*-32.8*	*-18%*
Wayne	*702.6*	*657.2*	(	*154*)	*-77.1*	*-48.8*	*113.1*	*58.1*	*45.3*	*7%*
Wexford	81.7	86.8	(	30)	1.3	22.3	1.0	-29.8	-5.1	-6%

Table 33 (cont'd).

Boat days (000') Destination County/Region	Distribution Model	Survey Estimates[a]		Difference[b] Marina	Second Home	Waterfront Home	Non-waterfront Home	All	Percent difference[c]
County Level Estimates For Counties With Sample Sizes Smaller Than 30 Boats									
Alger	*39.8*	*59.0*	*(24)*	*-7.6*	*3.7*	*-4.3*	*-11.0*	*-19.1*	*-32%*
Baraga	*34.7*	*18.1*	*(21)*	*-3.4*	*6.6*	*7.0*	*6.3*	*16.5*	*91%*
Branch	*121.7*	*119.3*	*(16)*	*7.5*	*38.5*	*-58.7*	*15.0*	*2.3*	*2%*
Calhoun	*90.0*	*45.5*	*(8)*	*3.0*	*-11.3*	*27.8*	*24.9*	*44.4*	*98%*
Cass	*159.5*	*230.3*	*(27)*	*-32.4*	*37.7*	*-76.5*	*0.4*	*-70.8*	*-31%*
Clare	*151.7*	*114.1*	*(19)*	*2.4*	*43.5*	*9.0*	*-17.3*	*37.6*	*33%*
Clinton	*39.9*	*26.1*	*(4)*	*0.1*	*1.0*	*8.2*	*4.5*	*13.7*	*53%*
Crawford	*105.0*	*42.8*	*(14)*	*-1.3*	*32.2*	*8.8*	*22.6*	*62.2*	*145%*
Dickinson	*72.7*	*11.8*	*(8)*	*0.0*	*32.9*	*17.9*	*10.2*	*60.9*	*518%*
Eaton	55.9	1.8	(1)	0.1	3.3	36.1	14.8	54.2	3059%
Genesee	231.1	174.2	(28)	-9.7	2.2	49.3	15.2	57.0	33%
Gladwin	127.2	122.6	(28)	2.0	-8.3	23.0	-12.0	4.6	4%
Gogebic	57.9	38.5	(17)	1.2	-10.9	19.2	9.9	19.4	50%
Gratiot	24.2	52.5	(5)	0.2	2.4	-2.8	-28.1	-28.3	-54%
Hillsdale	81.9	62.5	(7)	1.7	-10.8	14.3	14.2	19.4	31%
Ingham	113.4	2.5	(4)	0.0	7.7	72.7	30.5	110.9	4442%
Ionia	46.9	51.9	(10)	0.4	-29.9	12.3	12.2	-5.0	-10%
Iron	92.8	88.1	(17)	0.0	-4.5	11.7	-2.5	4.7	5%
Isabella	48.1	46.6	(14)	-0.8	-9.0	14.6	-3.2	1.5	3%
Kalkaska	75.3	30.4	(7)	1.7	29.6	17.4	-3.8	44.8	147%
Keweenaw	39.2	17.0	(27)	2.3	3.1	-0.8	17.6	22.2	131%
Lake	130.7	121.8	(12)	0.9	-23.8	4.3	27.5	8.9	7%
Lapeer	62.9	36.7	(10)	1.8	16.3	14.7	-6.6	26.2	71%
Lenawee	122.6	161.3	(16)	-0.7	29.4	-54.3	-13.2	-38.7	-24%
Livingston	231.7	257.8	(26)	13.9	0.8	-121.1	80.3	-26.0	-10%
Luce	35.7	9.4	(5)	0.2	3.1	10.1	12.9	26.3	280%
Midland	67.2	108.9	(12)	0.4	0.5	17.0	-59.7	-41.7	-38%
Missaukee	54.0	85.2	(13)	0.8	11.2	-23.5	-19.7	-31.2	-37%
Montcalm	133.9	209.3	(25)	5.3	7.2	-42.9	-44.9	-75.3	-36%
Montmorency	85.8	96.2	(15)	4.8	-14.7	5.2	-5.8	-10.4	-11%
Ogemaw	127.7	62.3	(16)	2.4	36.7	7.7	18.7	65.5	105%
Ontonagon	32.8	17.1	(19)	1.8	7.8	5.2	0.9	15.6	91%
Osceola	69.7	94.7	(11)	0.5	12.6	-43.3	5.3	-25.0	-26%
Oscoda	95.6	24.7	(12)	-1.5	45.5	10.0	16.8	70.9	287%
Otsego	89.7	63.6	(12)	2.8	-1.2	15.7	8.8	26.0	41%
Saginaw	65.0	36.0	(16)	-2.0	-11.2	14.4	27.8	29.0	81%
Sanilac	95.3	31.7	(24)	16.7	42.0	-8.0	12.9	63.6	201%
Schoolcraft	76.3	33.1	(12)	1.5	19.4	10.5	11.8	43.2	131%
Shiawassee	72.6	84.3	(13)	9.1	-31.1	-17.8	28.1	-11.7	-14%
St Joseph	80.3	5.6	(2)	0.1	33.2	35.8	5.7	74.7	1339%
Tuscola	66.0	64.4	(26)	7.7	2.1	-1.9	-6.2	1.6	3%
Washtenaw	190.2	158.7	(26)	7.6	-5.6	36.9	-7.5	31.4	20%

a. Numbers in the parentheses are the unweighted count of cases in the county from the 1994 Michigan Boating Survey.

b. Difference is caculated as estimates from trip distribution model substract the estimates from survey observed.

c. Percent difference is caculated as the difference over the estimates from survey observed.

does not reveal which estimate is more accurate. For example, direct survey estimates are quite different for Barry and Kalamazoo counties. Because these two adjacent counties have similar population sizes and boating opportunities, they are expected to have similar boating use in the counties. The survey estimates twice as many days in Barry county than Kalamazoo county. The model predicts a similar number of days in both counties. It appears that model estimate is more reasonable.

Table 34 is a comparison of survey based and model estimated origin (storage) - destination (use) matrices. The origin-destination matrix estimated from the 1994 Michigan Boating Survey is reported in Table 5 on page 21. Table 32 on page 131 shows the model estimated matrix. The matrix is used to evaluate how well the model predicts the flows of boat days. The cells report the absolute and percent differences between the survey based and model based estimates. The diagonal cells highlight differences between the survey based and model estimated origin-destination matrices. The diagonals are boat days that occur within the regions by boats stored in those regions. For example, the difference between the model based and survey based estimates of boat days occurring in the northeast region by boats stored in the region is 140,420 days. This is a 22% difference. With the exception of central-east, northeast, and southern Upper Peninsula regions, the percent differences for the estimates in the diagonal cells are less than 12%. The differences between the two estimates are largely attributed to the differences between survey and model estimates of the total number of boat days in storage regions. For example, the average number of boat days by boats stored in the central-east region is less than the state average (Table 20). This results in a 37% difference between the model

Table 34. Boat Days by Storage Region and Destination Region: A Comparison of Survey and Trip Distribution Model Estimates.

Boat Days (000')	REGIONS OF STORAGE										
Destination Regions	South-East	Central-East	North-East	North-West	Central-West	South-West	South Inland	North Inland	U.P. South	U.P. North	Total
South East	**-213.46**	11.38	-1.88	2.58	3.45	0.28	6.16	-1.91	0.11	0.47	-192.81
Percent Difference	**-10.6%**	1014.4%	-45.9%	1193.8%	NA	16.2%	8.8%	-88.0%	82.2%	NA	-9.3%
No. of boats survey based	**(505)**	(5)	(2)	(1)	(0)	(4)	(23)	(2)	(1)	(0)	(543)
Central East	5.61	**110.04**	-0.30	-0.72	1.13	2.00	-13.86	0.48	-0.42	0.08	104.05
Percent Difference	31.6%	**31.2%**	-19.0%	-39.2%	NA	418.2%	-20.0%	37.1%	-90.2%	NA	23.3%
No. of boats survey based	(21)	**(216)**	(12)	(1)	(0)	(1)	(23)	(3)	(1)	(0)	(278)
North East	6.98	2.73	**140.42***	0.43	3.43	1.69	-0.02	-5.92	0.08	0.64	150.44
Percent Difference	65.9%	9.6%	**22.1%**	12.6%	237.4%	765.5%	0.0%	-42.4%	32.1%	1027.0%	20.3%
No. of boats survey based	(6)	(57)	**(282)**	(12)	(5)	(1)	(21)	(12)	(2)	(2)	(400)
North West	9.87	14.22	1.13	**24.47**	4.69	-11.02	-10.33	-13.37	0.44	0.83	20.93
Percent Difference	50.5%	506.4%	40.3%	**2.0%**	63.5%	-56.4%	-14.1%	-46.5%	149.2%	NA	1.5%
No. of boats survey based	(10)	(5)	(14)	**(591)**	(31)	(12)	(24)	(23)	(1)	(0)	(711)
Central West	10.48	3.53	0.13	2.26	**57.87**	-11.01	-11.97	5.25	0.08	-0.13	56.50
Percent Difference	705.4%	6649.5%	21.8%	521.7%	**12.7%**	-63.8%	-25.9%	404.1%	NA	-45.9%	10.8%
No. of boats survey based	(1)	(1)	(3)	(3)	**(269)**	(28)	(26)	(2)	(0)	(2)	(335)
South West	4.81	2.48	0.51	-0.25	-12.03	**-21.43**	-5.73	0.27	0.06	0.11	-31.21
Percent Difference	242.4%	NA	NA	-23.7%	-49.7%	**-4.4%**	-10.0%	NA	NA	NA	-5.5%
No. of boats survey based	(1)	(0)	(0)	(0)	(27)	**(180)**	(13)	(0)	(0)	(0)	(221)
South Inland	24.09	-2.15	-0.32	-2.15	-7.92	-9.25	**70.84**	-6.23	0.00	0.00	66.90
Percent Difference	26.8%	-15.0%	-76.2%	-71.5%	-37.3%	-24.7%	**2.1%**	-65.6%	NA	NA	1.9%
No. of boats survey based	(20)	(3)	(1)	(2)	(4)	(7)	**(421)**	(4)	(0)	(0)	(462)
North Inland	7.75	5.05	2.74	2.84	6.32	5.61	-43.43	**-72.35**	0.27	0.08	-85.12
Percent Difference	21.8%	19.8%	883.3%	99.8%	97.0%	NA	-28.6%	**-4.6%**	NA	135.8%	-4.8%
No. of boats survey based	(8)	(8)	(1)	(3)	(4)	(0)	(50)	**(276)**	(0)	(1)	(351)
U.P. South	10.44	7.39	-1.87	-3.35	3.03	0.46	12.10	-0.11	**-115.65**	3.42	-84.14
Percent Difference	221.7%	709.1%	-57.7%	-60.0%	45.4%	92.1%	102.3%	-1.8%	**-17.7%**	208.7%	-12.1%
No. of boats survey based	(3)	(4)	(23)	(29)	(3)	(2)	(9)	(5)	**(208)**	(10)	(296)
U.P. North	4.30	3.60	-0.53	0.50	-3.18	-6.33	-4.66	0.10	-7.53	**8.21**	-5.53
Percent Difference	15.1%	98.9%	-38.6%	18.5%	-19.1%	-84.1%	-13.3%	0.3%	-64.2%	**1.9%**	-1.0%
No. of boats survey based	(5)	(4)	(14)	(15)	(3)	(3)	(13)	(6)	(19)	**(229)**	(311)
Total	-129.13	158.26	140.03	26.61	56.79	-49.01	-0.91	-93.80	-122.56	13.72	**0.00**
Percent Difference	-5.8%	36.8%	21.5%	2.2%	10.5%	-8.6%	0.0%	-5.7%	-18.4%	3.2%	**0.0%**
No. of boats survey based	(580)	(303)	(352)	(657)	(346)	(238)	(623)	(333)	(232)	(244)	**(3908)**

* 140,400 days are the difference between the model estimate (776,300 days in Table 32) and survey based estimate (635,900 days in Table 5) of boat days in the northeast region by boats stored in the region

estimates of total boat days (588,300 days) and survey estimates (430,100 days) by boats stored in the central-east region. Since approximately 80% of those boat days remains within the central-east region (Table 32), the difference between the two estimates contributes to the 31% difference between the model and survey estimates of the number of boat days occurring in the region by boats stored in the region.

CHAPTER V

CONCLUSIONS

Timely and accurate boating use information is important for planning, management and marketing undertaken by agencies, boating organizations, and boating related businesses. There is a special need for regular estimates of boating use (e.g., number of boats in different types of storage, number of boats kept in counties, boating days in counties) for management, feasibility assessment and planning. Currently the only sources of information are state registration data, state-wide boater surveys, and local and special purpose studies. Although boat registration data are potentially useful, they do not provide a direct means to estimate boating use or boat storage. The problems with state-wide boater surveys are that they are costly (averaging about $10.00 per usable questionnaire), they are conducted five to eight years apart, and sample sizes are insufficient to produce reliable estimates of boating use for counties or Great Lakes ports. Local (e.g., feasibility of a particular marina) or special purpose studies do not provide information to evaluate trends or spatial patterns of boating use. Often local or special purpose studies rely on state-wide boating surveys or registration data as starting points to estimate local boating use.

The primary objective of this study was to develop a system of models which utilizes various secondary data sources to produce reliable county level estimates of boating use by boats in different types of storage. This chapter reviews the structure and

components of the system, summarizes and evaluates the performance of the system, and discusses some limitations of the system and recommendations for improving and implementing the system.

THE SYSTEM OF MODELS

The system of models utilizes boat registration data and the recent survey to estimate boating use at regional and county levels. The system include classification, boat allocation, trip generation and trip distribution models. A discriminant analysis is used to classify registered boats into (type of) storage segments -- marinas, second homes, permanent waterfront homes and permanent nonwaterfront homes. Boats in each storage segment are then allocated to the counties where they are stored using a set of allocation models. Allocation models were developed for four storage segments. The number of boat days in (destination) counties by boats in different storage segments is estimated by a trip generation model and a set of trip distribution models. A trip generation model is used to predict number of boat days in the county of storage. Then those boat days are distributed to the destination counties by trip distribution models for boats at each storage segment.

Models are linked together into a system. The estimates of one model are used as an input for the next model. For example, the number of boats stored in each county is an input for the trip generation model which is further input to the distribution model. Both allocation models and trip distribution models are based on the distinct boating use characteristics and patterns of boats in different storage segments. For example, different

trip distribution models are established for boats stored at marinas in coastal counties and boats stored at nonwaterfront homes.

Compared to direct survey based estimates, the system of models provides somewhat more robust use estimates by drawing upon several independent sources of data and by linking various types of models together. Boat registration counts, marina inventories and other local boating opportunity indices help to ground the estimates at the county level. Recreational travel theories (i.e., distance decay) and information on boating use patterns identified in previous boating studies provide the conceptual basis for the models. In particular, most boating occurs either close to home, or close to where boats are stored during the season. Marinas and second homes are the primary types of storage away from the boat owner's primary residence and therefore explain a considerable share of inter-regional flows from residence location to storage location. On the other hand, three primary reasons for boats traveling outside the storage counties are (1) boats stored near county boundaries boating in nearby counties, (2) boats on extended overnight cruises, and (3) boats kept at nonwaterfront homes trailering to boating sites.

THE MODELS AND ESTIMATES OF BOATING USE

This section evaluates the overall performance of the system of models including the boating use estimates predicted by the system of models, and the principal modeling strategies used in the system. The models should provide cost-effective estimates of boating use that are (1) current and (2) reliable at the regional and county level. The approach to modeling boating use is different from previous attempts in that two different

modeling strategies are employed: (1) incorporating type(s) of storage as the principal structure of the system, and (2) inserting storage location as an intermediate stage between location of the owner's residence and (use) destination location.

The boating use estimates produced by the system of models capture the spatial patterns of Michigan boating use. The predominate "south-to-north" spatial patterns predicted by the system of models confirm similar travel patterns observed in previous Michigan boating studies. The system of models shows that the "south-to-north" spatial patterns occur when boats are moved from the owners' residence to locations where boats are kept during the boating season. The pattern also exists when boats are moved from their storage location to the (use) destinations. The models also reveal that southern Michigan has the largest number of boats registered, the largest number of boats kept in the region during the boating season, and the largest number of boat days (used) in the region.

It is difficult to assess the accuracy of boating use estimates produced by the system of models because there is no reliable secondary source of information on boating use -- boats stored or used in regions or counties. Direct estimates from the 1994 Michigan Boating Survey are compared with the model estimates, but the direct survey estimates are subject to sampling errors. County level estimates are usually subject to large sampling errors, especially for the counties where less than 30 1994 Michigan Boating Survey questionnaires were returned. For example, based on questionnaires representing 25 boats, the survey estimated that boats kept in Benzie county average 30 days of use. The standard error of mean is ±5 days for this estimate. In comparison, the

survey estimate of boating use in the northwest region is also 30 days, but it is based on 471 questionnaires. The standard error of mean is ±1 day for this estimate. The estimate of average boat days at the regional level is much more reliable than the estimate at the county level.

A comparison of model predictions with direct survey based estimates shows that the model estimates of boating use are within 10% of survey estimates for most regional estimates. Regional estimates of boat days by marina stored boats produced by the distribution model are within 10% of direct survey estimates for every region except for the southern Upper Peninsula. The estimates of days by boats kept at nonwaterfront homes are within 10% of survey estimates for each region, except for the south-west. The regional estimates by overall trip distribution model are within 12 % of survey estimates, except for the central-east and north-east regions. Model estimates that differ more than 10% from survey estimates are for regions where a relatively small number of 1994 surveys were returned.

A comparison of model predictions with survey estimates for counties with sample sizes more than 30 boats indicates that model estimates are reasonably accurate. Storage allocations are within 20% of survey estimates for 22 of 32 counties. Estimates of total boat days predicted by the trip distribution models for the four storage segments are within 10% of survey estimates for 13 (of 41) counties, and between 11-30% for 14 (of 41) counties. County estimates of boat days by marina stored boats are within 20% of survey estimates for every county with a sample size over 30.

Sampling errors at county level associated with survey estimates are likely much larger than the errors in the model estimates. For example, direct survey estimates of the number of boat days are quite different for Barry and Kalamazoo counties. These two adjacent counties have similar populations and boating opportunities. The survey estimates twice as many days in Barry county than Kalamazoo county. The model predicts a similar number of days in both counties.

The system of models improves the efficiency of estimating boating use by incorporating multiple data sources, linking several types of models and generating various types of boating use estimates. The system of models is developed based on a large state-wide boating survey, regularly collected data sets (e.g., boat registrations, transient slip rentals) and other secondary data sets regarding the inventories of boating related resources/facilities. The Michigan boating survey provides a necessary basis for developing and evaluating the models comprising the system. By combining models estimated periodically from the state-wide boating survey with data that are gathered on a regular basis and information on county's boating "supply" variables, the system of models can produce up-to-date use estimates and predict boating use down to the county level.

The linkages of models comprising the system also improve the efficiency of the estimates. Estimates from individual models provide important boating use estimates. In addition these estimates are used as inputs to other models in the system. Linking the different models reduces data requirements for the individual models. For example, estimates of the number of boats stored in counties generated by the allocation models are

input to the trip generation model. Without the allocation model estimates, it would be necessary to have another source of information on the number of boats stored in counties. Currently this information is not collected on a regular basis by any agency or organization. In addition, the system of models provides various boating use estimates simultaneously -- number of boats stored in the counties within different storage segments, and the number of boat days in the (destination) counties by different storage segments. These estimates can easily be aggregated into regional estimates (i.e., various types of planning regions).

While linking the different models has a number of benefits, the downside is the potential propagation and masking (canceling out) of errors. If systematic errors exist in estimates produced by one model, they would be incorporated into estimates produced by models that rely on these previous estimates as input. For example, if there are errors in estimates produced by the regional allocation of boats, they will carry over to the county level allocation. Also, some errors may not be obvious because they can be canceled or masked by errors in estimates produced by other models in the systems. Monte Carlo simulation experiments could be conducted to assess aggregation/propagation errors.

The system of models shows that type of storage is very useful for predicting type, amount, and distribution of boating activities. There are significant differences in size and type (e.g., inboards, sail) of boats in different types of storage. The models also reveal that boats in different storage segments have distinct use patterns including counties where they are kept during the season, use locations, average number of boat days and

average travel distance. Incorporating types of storage into the system of models improve the estimates of the amount and spatial distribution of boating use.

Producing separate use estimates for boats in different storage segments also provides better information to assist public or private agencies with planning and management decisions. For example, the number of boats stored at marinas in a county is much more useful in determining the feasibility of a proposed marina than an aggregate estimate of all boats stored (or registered) in the county. Similarly, the spatial distribution of use by boats stored at nonwaterfront homes is especially relevant for assessing the need of public access sites.

The strategy of incorporating the location of storage into the system of models improves boating use estimates. Previous boating studies examined the spatial patterns of boating use only from the locations of the boat owner's residences to boating (use) destinations. The two-stage approach is employed in the system of models -- from owner's residence to storage location, then from storage location to boating (use) destination -- better captures variations in spatial movements. Almost half (46%) of boat days occur outside the counties where boat owners reside, but only 17% occur outside the county where the boat is kept during the season. Spatial movement from locations of residence to use destinations is largely explained by the movement from the location of residence to the storage location. This approach is also helpful to model the spatial movement for boats kept in different types of storage. For example, 83% of boat days by boats stored at second homes occur outside the county where the boat owners reside. Almost all of those boat days occur in the county where the second home is located.

Therefore, there is no need to model distribution of days from storage location to use location.

LIMITATIONS AND RECOMMENDATIONS

This section discusses study limitations and recommendations. First, the 1994 Michigan Boating Survey was the primary data source used to develop and evaluate the system of models. Several survey estimates such as the distribution of boats in storage regions by boats in different storage segments, the average number of boat days by storage segments, and the distribution of boat days within destination zones by (storage) regions are key components of the models. Therefore, the predictions by the system of models are subject to the sampling errors associated with these estimates.

With 3,000 returns for the 1994 Michigan Boating Survey, most estimates at the regional level are reliable. However, this sample size is insufficient to generate reliable estimates of use by boats in different storage segments for some of the regions. For these regions, there is some concern about using these estimates as a basis for the allocation and distribution models. Reducing the number of categories and segments would lower sampling errors associated with the survey estimates. For example, fewer destination zones may be used for boats kept at nonwaterfront homes. On the other hand, further research should focus on models (i.e., spatial distribution models or probability models) that can predict those regional distributions.

The trip generation model utilizes statewide averages of boat days to estimate number of days generated by boats stored in counties for each type of storage. Although

analysis of variance indicates that there is no statistically significant difference across regions for boats in most of the storage segments, there still is considerable variation in the estimates of average boat days. Instead of state average boat days, other estimates such as average boat days for different regions (i.e., Upper Peninsula, northern Lower Peninsula, and southern Lower Peninsula) or average boat days for coastal counties and for inland counties should be considered for the trip generation model. Future research should focus on testing the application of more sophisticated causal models to produce more reliable estimates than those generated directly from the surveys.

The 1994 Michigan Boating Survey provided important data for developing and evaluating the system of models. Boaters should be surveyed periodically to identify changes in market structure, boater behavior and use patterns in order to update model parameters. A much shorter and less costly survey than was conducted in 1994 could provide adequate information to update the models.

Secondly, the accuracy of county level estimates depends on the measures (indices) of a county's boating opportunities. Reliance on secondary sources of information on the "supply" of boating opportunities in counties raises some concerns. This is true especially when there are no inventories or information about county boating opportunities that are incorporated into the models. For example, there is no accurate count of the number of marinas, storage facilities or boating resources in inland counties. Number of lakes and acres of lakes was used as a proxy for marina spaces in inland counties. Further research should be directed at constructing recreational boating opportunity indices, evaluating appropriate measures of boating opportunities in a given

area, and determining the relationships between such boating opportunity indices and the type and amount of boating activities (i.e., the relationship between various supply variables and the boating "demand").

Third, the estimates of boating use produced by the models are for boats with valid Michigan Registrations. The estimates do not include non-motorized boats and boats under 16 feet in length. In some inland counties, days by non-registered boats could represent a relatively large share of boating activities. Estimates of the number of non-registered boats and their use are needed for the system to produce comprehensive estimates of boat use.

In addition, locations where boats are kept during the season and types of storage should be collected as part of Registration Data. This would eliminate the need to estimate this information and it will enhance the ability of the system of models to provide reliable, comprehensive and up-to-date estimates of boating use.

APPLICATIONS

The models provide important information for management, marketing and economic impact assessment. Model produced estimates of the number of boats kept in different counties and the number of boat days by boats in different types of storage can be used to assess the current adequacy and "need" for boating facilities/services. The Michigan Legislation and Department of Natural Resources also require reliable estimates of the amount and locations of boating use to formulate and assess regulations and policies. Origin and destination patterns are essential information for the design of

marketing and management strategies aimed at attracting different types of boaters and boating use. Currently this information is not available on a regular basis for regions and counties.

The system of models can be the bases for a recreational boating information system to support planning and management decisions. Such an information system can serve the Michigan boating (industry) better by providing reliable boating use information more conveniently and by matching information with the needs of planers and managers. With some additional works, the system of models can be made more user-convenient. Currently the system of models is developed on Microsoft Excel spreadsheets. Additional programming is needed to make the system more "user friendly" including: (1) capability to generate standard reports, (2) the ability to modify model parameters, (3) updating data on which models are based, and (4) providing different options for users. Additional programming and instruction on use of the system will facilitate use by agencies and organizations.

APPENDIX A

APPLICATION FOR CERTIFICATE OF WATERCRAFT TITLE AND/OR REGISTRATION

APPLICATION FOR CERTIFICATE OF WATERCRAFT TITLE AND/OR REGISTRATION

ROTARY MULTIFORMS INC 616-943-8574 [redacted] 90

(Enter Hull Material, Type, Power, Use and Fuel From the List Below)

MICHIGAN REGISTRATION

EXPIRES ON

WATERCRAFT MC

Year	Make	Length Ft In	Reg Fee
Hull Identification Number	County of Residence	Code	Title Fee
Hull Material	Code Type	Code	Tax
Power	Code Use	Code	Reg Transfer
Date of Birth	Code Driver License Number		Total

Owners' Complete Name(s) and Address

RICHARD H. AUSTIN Secretary of State

MICHIGAN REGISTRATION

EXPIRES ON

WATERCRAFT MC

Year	Make	Length Ft In	Reg Fee
Hull Identification Number	County of Residence	Code	Title Fee
Hull Material	Code Type	Code	Tax
Power	Code Use	Code	Reg Transfer
Fuel	Code Model or Series Number		Total

Owners' Complete Name(s) and Address

Amount Received | Change

DATE PURCHASED Month Day Year

Seller(s)

Street Address

City and State Zip Code

☐ OWNER ☐ OTHER NAME: _____

I.D. PRESENTED: _____

Title Information Changed: _____

Title Being Replaced: ☐ Lost ☐ Stolen ☐ Mutilated (attached)

USE THIS SECTION FOR TAX EXEMPT TRANSACTIONS
(See Instructions On Reverse Side)

[ ] Transferred from immediate relative (see reverse) State relationship

[ ] Other

LEGAL PAPERS

Type of Document	County	State
Court	File or Docket Number	Date Examined
Branch Office	Examiner (Print)	

IF YOUR TITLE IS NOT RECEIVED WITHIN 60 DAYS FROM THE DATE OF FILING, CONTACT A SECRETARY OF STATE OFFICE.

[ ] COMMENTS - See Back

Owner's Signature _____

Hull Identification Number

Full Rights to Survivor | Filing Date 1st Secured Interest | Filing Date 2nd Secured Interest

1st Secured Interest (Bank or Credit Union)

Street Address

City and State Zip Code

2nd Secured Interest

Street Address

City and State Zip Code

USE TAX RETURN

Do not complete if applying for a duplicate title

1. Full purchase price or retail dollar value whichever is greater $
2. 4% (.04) $
3. Credit for tax paid to a reciprocal state (proof attached) $
4. Amount of tax being paid $

Enter the Description and Code Number in the Matching Box Above

HULL MATERIAL	TYPE	POWER	USE	FUEL
1 Wood	1 Open	1 Inboard	1 Pleasure	1 Gas
2 Steel	2 Cabin	2 Outboard	2 Commercial	2 Diesel
3 Fiberglass	3 Sail	3 Sail	3 Livery	3 Electric
4 Aluminum	4 Row	4 Sail/Power	4 Other	
5 Other	5 Canoe	5 Other Power	5 Commercial Freight	
	6 Pontoon	6 No Power	6 Commercial Fishing	

I CERTIFY I OWN THIS VESSEL AND ALL INFORMATION SHOWN ON THIS FORM IS CORRECT TO THE BEST OF MY KNOWLEDGE

New Owner's / Applicants Signature(s)

X _____

X

UPON SALE OF THIS VESSEL PRESENT THIS REGISTRATION (AND TITLE, IF ISSUED) TO THE PURCHASER

ON THIS DATE

[ ] I sold or transferred this vessel (Present this registration to new owner.) Selling Price $

[ ] I changed my address

[ ] I destroyed or abandoned this vessel

NEW OWNER'S COMPLETE NAME

STREET ADDRESS

CITY STATE ZIP CODE

I certify the above statement is true

Owner's Signature X

The number assigned to this vessel is permanent and cannot be transferred to any other vessel.

Vessel operator is required to render assistance and report any marine accident to the nearest police officer, state police post or sheriff of the county in which the accident occurs.

USE TAX RETURN

THE SECTION PROVIDING FOR PAYMENT OF TAX IS COMPLETED AS FOLLOWS:

Line 1 Enter the full purchase price or retail dollar value. The full purchase price includes the full amount paid to the previous owner together with any outstanding debt owed. Such payment means money, credit, services rendered, trades, or anything of value. The amount allowed for trade-in is not deductible.

Retail Dollar Value: If a definite dollar value has not been established before applying for title, the price to be used in computing tax shall not be less than the vessel's suggested retail dollar value as listed in any currently recognized appraisal guide.

Line 2 Enter four percent (4%) of the amount of line 1.

Line 3 Enter any Sales or Use Tax paid in another state (including tax paid to local government units) which is reciprocal with Michigan. Submit proof.

Line 4 Enter the amount of use tax due. If line 3 is completed, the tax due will be the difference between line 2 and the tax shown as paid on line 3. In all other cases, line 4 will be the same as line 2.

EXEMPTION — Transfers Between Relatives:

An exemption from use tax is allowed when the new owner is the spouse, father, mother, brother, sister, or child of the previous owner. Documentation proving the relationship may be requested by the Department of Treasury.

Final determination of the correct tax liability is made by the Michigan Department of Treasury. You may be required to document your tax return or prove you are entitled to the exemption claimed. If you cannot support your claim, additional penalties include the added tax, a negligence penalty, plus interest from the date of filing this application. Additional penalties can be imposed including criminal prosecution or assessing up to 175 percent of the tax due.

A person who violates a provision of this section with intent to defraud or to evade the payment of a tax or a part of the tax is guilty of a felony, punishable by a fine of not more than $5,000.00 or imprisonment for not more than 5 years, or both. Sec. 27, Public Act 162 of 1982.

MICHIGAN REGISTRATION RICHARD H. AUSTIN Secretary of State

WATERCRAFT (See Instructions on Back)

Expires on

MC

Year	Make	Length Ft. In.	Fee

Hull Identification Number	County of Residence	County Code

Hull Material	Code	Type	Code	Power	Code

Use	Code	Fuel	Code

Owner's Complete Name and Address

Signature of Owner or Representative

WR 1C (3-87)

Amount Received	Change

MICHIGAN REGISTRATION RICHARD H. AUSTIN Secretary of State

WATERCRAFT

Expires on

MC

Year	Make	Length Ft. In.	Fee

Hull Identification Number	County of Residence	County Code

Hull Material	Code	Type	Code	Power	Code

Use	Code	Fuel	Code

Owner's Complete Name and Address

Owner's Signature

WR 1C

REGISTRATION MUST BE IN POSSESSION OF OPERATOR WHENEVER THE VESSEL IS IN USE 2

UPON SALE OF THIS VESSEL, PRESENT THIS REGISTRATION (AND TITLE, IF ISSUED) TO THE PURCHASER

ON THIS DATE

- [ ] I sold or transferred this vessel (Present this registration to the new owner.)
- [ ] I changed my address
- [ ] I destroyed or abandoned this vessel

New Owner's Complete Name and Address

I HEREBY ATTEST TO THE ACCURACY OF THE ABOVE STATEMENT

Owner's Signature

Number assigned to this vessel is permanent and shall not be transferred to any other vessel.

Vessel operator is required to render assistance and report any marine accident to the nearest peace officer, state police post or sheriff of the county in which the accident occurs.

Authority granted under Act 303 of 1967, as amended

NOTICE

The Federal Boat Safety Act of 1971 requires all states to compile more detailed information on boats. Therefore, the State of Michigan must request that you complete this registration in detail.

INSTRUCTIONS

1. Part 1 & 2 must be filled out completely.
2. Write the appropriate number and description in the matching box on the front of the application. Use only one number and description for each box.

HULL MATERIAL	TYPE	POWER	USE	FUEL
1 Wood	1 Open	1 Inboard	1 Pleasure	1 Gas
2 Steel	2 Cabin	2 Outboard	2 Commercial	2 Diesel
3 Fiberglass	3 Sail	3 Sail	3 Livery	3 Electric
4 Aluminum	4 Row	4 Sail w. Power	4 Other	
5 Other	5 Canoe	5 Other Power	5 Commercial Freight	
	6 Pontoon	6 No Power	6 Commercial Fishing	

APPENDIX B

1994 MICHIGAN RECREATIONAL BOATING SURVEY QUESTIONNAIRE

1994 MICHIGAN RECREATIONAL BOATING SURVEY

1. How many boats do you own that were registered in Michigan in 1994? _____

IF YOU OWN MORE THAN ONE BOAT THAT IS REGISTERED IN MICHIGAN, PLEASE ANSWER THIS SURVEY ONLY FOR THE BOAT IDENTIFIED IN THE ADDRESS LABEL ON YOUR ENVELOPE.

2. Was your boat used for recreation in Michigan in 1994?

☐ YES ☐ NO ⇨ IF YOUR BOAT WAS INACTIVE IN 1994, PLEASE SKIP TO QUESTION 24 AND FOLLOW THE INSTRUCTIONS FOR RETURNING THIS SURVEY

⇩

DESCRIPTIVE INFORMATION ABOUT YOUR BOAT

3. Type of boat (check one) :
☐ Inboard ☐ Inboard/outboard ☐ Outboard
☐ Sail, unpowered ☐ Sail, with power ☐ Pontoon
☐ Canoe or Row ☐ Personal watercraft (e.g. Jet ski) ☐ Other, please specify _____

4. Boat length (feet) _____

5. How long have you owned this boat? _____ years _____ months

6. Where did you usually keep this boat during the 1994 boating season?

a. County where the boat was kept _____

b. Type of facility (check one):
☐ permanent residence
☐ cottage or second home
☐ public marina
☐ rented space in a commercial marina
☐ owned space in marina or dockaminium
☐ yacht / boat club
☐ Other (please specify) _____

c. During the 1994 boating season, where was your boat kept ?
☐ On land
☐ In a dry stack facility
☐ In the water (wet slip, mooring or dockside)
☐ Attached to or on a larger boat
☐ Other (please specify) _____

d. Was this location (check one):
☐ A waterfront site with access to the Great Lakes & connecting waters
☐ An inland lake waterfront site (no Great Lakes access)
☐ A river or stream waterfront site (no Great Lakes access)
☐ A non-waterfront site

7. In 1995 do you intend to (check one): ☐ Continue to use this boat ⇩ ☐ Sell or dispose of this boat ⇨ Skip to Question # 8

7a. Will this boat be registered in Michigan in 1995? ☐ YES ☐ NO

7b. During the 1995 boating season, will you keep this boat in the same county as in 1994?
☐ YES ☐ NOT SURE ☐ NO ⇨ What county in 1995? _____

7c. In 1995, will you keep this boat in the same kind of facility as in 1994 (see categories in question 6b)?
☐ YES ☐ NOT SURE ☐ NO ⇨ What type of facility in 1995? _____

7d. Will you have direct access to Great Lakes waters from this facility in 1995?
☐ YES ☐ NO

USE OF YOUR BOAT IN MICHIGAN WATERS IN 1994

8. Please estimate to the best of your recollection the total number of days this boat was used in Michigan waters in 1994, whether by you or someone else. Count each day or part of a day that the boat was underway as one day of boating. Report days of use only for the boat you described above.

_____ **TOTAL DAYS THIS BOAT WAS USED IN MICHIGAN DURING 1994**

9. Now please divide this use between GREAT LAKES and INLAND boating using the definitions at the right. Your estimates of GREAT LAKES and INLAND boating use should sum to the total you entered in question 8.

_____ **GREAT LAKES BOATING DAYS** = any days that the boat was underway on the Great Lakes and connecting waterways (*Lakes Huron, Superior, Erie, Michigan, and St. Clair, the St. Mary's, St.Clair and Detroit River*), including lakes and rivers that provide access to the Great Lakes.

_____ **INLAND BOATING DAYS** = any days the boat was underway only on inland lakes and streams that do not provide direct access to the Great Lakes.

10. In the table below name the Michigan counties (see the enclosed map) in which this boat was used in 1994, beginning with the location used most frequently. In Column B, estimate the total number of days the boat was underway in each of these counties. In column C, enter the number of these days that the boat was used on the Great Lakes or connecting waters in this county (as defined above).

		Column B	Column C
BOATING USE BY COUNTY	MICHIGAN COUNTY (see map for county names)	Days boat was used in this county in 1994, all waters	Days boat was used in this county, Great Lakes waters
EXAMPLE	Ottawa	17	6
County used most often			
County used 2nd most often			
County used 3rd most often			
All other counties	ALL OTHER COUNTIES		

Note: If you boated in more than one county on the same day, assign that day to the county used for the most time. If you boated in more than three counties in 1994, record the days the boat was used in all other counties in the final row. See enclosed map for county names.

11. Estimate the percentage of use of this boat in 1994 that involved each of the following activities. (The four percentages should add to 100%. Enter zero if you did not use this boat for a given activity.)

Pleasure boating _____%

Fishing from boat _____%

Waterskiing _____%

Other (e.g. scuba, hunting from boat,...) _____%

TOTAL SHOULD EQUAL 100%

12. **Transporting & Launching.** In 1994, how many times was this boat transported from your home or other location to one or more launching sites or marinas in Michigan? (Enter 0 if none)

____ Transporting to launch at sites with access to the **Great Lakes** in Michigan

____ Transporting to launch at sites on **Inland Lakes or rivers** in Michigan

13. In 1994, did you ever keep this boat overnight at a Michigan marina, yacht club or dockaminium for a short period (1-30 nights), for example while on an overnight trip? Do not include the facility where you normally keep your boat.

☐ YES ⇨ Number of nights in a temporary marina space in 1994? _____

☐ NO ⇩

14. **Annual Expenses for this boat.** Estimate the amount of money spent in 1994 to operate and maintain this boat. Report expenses only for the boat that you have described above. DO NOT include spending for consumable items used on boating trips or transportation to and from boating areas (for example, auto fuel, food, bait and lures).

Boat equipment (e.g., motors, trailer, anchors, sails, fishing, waterski, safety & electronic equipment, ..)	$_____	**Seasonal slip rental or dry stack storage**	$_____
Repair & Maintenance (e.g., to hull, motor, trailer, mast, sails, galley, deck, shaft, prop, docks, ...)	$_____	**Put in and haul out fees**	$_____
Boat Insurance	$_____	**Off-season storage**	$_____

15. How much money was spent on fuel for **this boat** in 1994? $_____

16. Are there fixed or portable toilet facilities on this boat? ☐ YES ☐ NO ⇨ Skip to Question 17

⇩

a. What kind? (check each type that you have and complete questions below that column)

☐ HEAD/INSTALLED TOILET (fixed on the boat)

b. How often is the head used on the boat?

Most Trips ☐ Some Trips ☐ Rarely ☐ Not Used ☐

c. How many times did this boat use a pumpout facility in Michigan in 1994?

_____ times used a pumpout

☐ PORTABLE TOILET (removable from boat)

b. How often is a portable toilet used on the boat?

Most Trips ☐ Some Trips ☐ Rarely ☐ Not Used ☐

c. Where do you usually empty your portable toilet?

☐ At a dump station
☐ In a public restroom
☐ At a home or cottage
☐ In the water
☐ Other

d. How often have you encountered problems in finding or using pumpout facilities or dump stations on your boating trips in Michigan? (Check one)

☐ MOST OF THE TIME ☐ SOMETIMES ☐ HARDLY EVER ☐ NEVER

INFORMATION ABOUT YOU AND YOUR FAMILY This information is requested to provide a profile of registered boat owners and to identify boating patterns for different subgroups of boaters.

17. Please give the county, state or province, and zipcode of your permanent residence.

_____ _____ _____
County State or Province Zipcode

18. Age of the boat owner _____ years

19. How many people, including yourself, reside in your household?

_____ Adults _____ Children under 18 years of age

20. What was your annual household income in 1994 ? (check one category below)

☐ Under $20,000
☐ $20,000- $39,999
☐ $40,000-$59,999
☐ $60,000-$99,999

21. Do you currently own a seasonal home, condominium or cottage in Michigan?

☐ YES ⇨ In what Michigan county is it located? _____ county
☐ NO

22. Do you intend to register any watercraft in 1995 that you did not own or register in Michigan during the 1994 boating season?

☐ NO ☐ NOT SURE ☐ YES ⇨ What size boat(s)? _____ feet

23. We are planning to ask a sample of boat owners to report their opinions about water quality issues and boating facilities in Michigan. Would you be willing to complete another short mailed survey about these topics?

☐ YES ☐ NO

24. THANK YOU VERY MUCH FOR YOUR HELP WITH THIS SURVEY. TO RETURN YOUR COMPLETED SURVEY, FOLD AND TAPE OR STAPLE IT SO THE RETURN ADDRESS SHOWS. MAIL IT FROM ANY U.S. POSTAL BOX.

61-7660

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 941 EAST LANSING, MI

POSTAGE WILL BE PAID BY ADDRESSEE

DEPARTMENT OF PARK, RECREATION AND TOURISM RESOURCES
MICHIGAN STATE UNIVERSITY
131 NATURAL RESOURCES BUILDING
EAST LANSING MI 48824-9902

APPENDIX C

INDICES OF BOATING OPPORTUNITIES

Appendix C. Indices of Boating Opportunities.

COUNTY	BOATING OPPORTUNITIES INDICES									
	GM[a]	LM[b]	SH[c]	RS[d]				GL[e]	CP[f]	TR[g]
				<16'	16'-20'	> 21'	>16'			
Alcona	101	NA	5,605	1,304	654	292	946	27	0.84	32.5
Alger	30	NA	1,858	1,118	265	157	422	120	0.29	67.5
Allegan	1,132	NA	2,730	5,885	2,365	1,267	3,632	24	1.31	22.9
Alpena	232	NA	1,810	2,875	964	427	1,391	61	0.89	37.8
Antrim	177	NA	4,695	2,626	1,249	677	1,926	27	0.97	36.5
Arenac	727	NA	2,413	1,009	1,849	404	2,253	47	0.32	27.8
Baraga	163	NA	1,142	611	197	92	289	70	0.48	46.1
Barry	NA	0.47	2,291	4,792	2,003	940	2,943	NA	NA	9.0
Bay	2,148	NA	327	4,834	2,836	2,135	4,971	36	0.30	19.0
Benzie	588	NA	3,145	2,069	847	304	1,151	25	2.81	47.5
Berrien	2,789	NA	4,448	7,573	3,133	2,013	5,146	14	1.33	6.6
Branch	NA	0.38	2,583	3,473	1,628	703	2,331	NA	NA	6.9
Calhoun	NA	0.15	10	6,738	2,414	922	3,336	NA	NA	4.2
Cass	NA	0.58	3,149	4,632	2,091	1,046	3,137	NA	NA	7.7
Charlevoix	1,450	NA	3,873	2,113	1,037	842	1,879	102	7.25	74.8
Cheboygan	729	NA	4,831	2,742	1,057	812	1,869	35	3.75	73.9
Chippewa	441	NA	4,787	2,837	1,108	433	1,541	456	3.73	207.9
Clare	NA	0.17	8,285	2,542	910	450	1,360	NA	NA	7.2
Clinton	NA	0.00	46	3,516	1,485	596	2,081	NA	NA	0.3
Crawford	NA	0.04	3,912	1,047	1,233	216	1,449	NA	NA	57.8
Delta	224	NA	2,412	3,131	992	281	1,273	199	1.19	104.3
Dickinson	NA	149.76	1,689	2,267	733	200	933	NA	NA	6.3
Eaton	NA	0.00	147	4,818	2,080	856	2,936	NA	NA	0.4
Emmet	567	NA	4,382	2,505	1,141	789	1,930	75	3.12	32.6
Genesee	NA	0.09	789	16,510	8,379	4,936	13,315	NA	NA	1.2
Gladwin	NA	0.14	5,492	2,188	1,340	685	2,025	NA	NA	7.8
Gogebic	41	NA	2,530	1,763	486	152	638	30	0.26	84.9
Grand Traverse	284	NA	3,296	6,238	3,007	2,008	5,015	56	2.05	58.9
Gratiot	NA	0.01	106	2,069	829	279	1,108	NA	NA	0.3
Hillsdale	NA	0.09	1,814	2,518	1,289	520	1,809	NA	NA	2.7
Houghton	157	NA	2,417	1,900	702	361	1,063	51	1.15	44.3
Huron	1,035	NA	5,100	1,361	977	687	1,664	93	2.03	46.8
Ingham	NA	0.00	346	9,472	4,132	2,051	6,183	NA	NA	0.4
Ionia	NA	0.02	390	3,044	1,135	405	1,540	NA	NA	1.7
Iosco	1,015	NA	6,643	2,960	1,391	583	1,974	36	1.96	27.3
Iron	NA	1,859.71	2,584	1,871	380	115	495	NA	NA	47.4
Isabella	NA	0.01	933	2,424	1,014	421	1,435	NA	NA	0.3
Jackson	NA	0.53	1,844	8,325	3,765	2,262	6,027	NA	NA	8.8
Kalamazoo	NA	0.40	614	10,493	4,578	2,531	7,109	NA	NA	7.0
Kalkaska	NA	0.12	3,466	1,513	477	321	798	NA	NA	14.5
Kent	NA	0.36	1,361	23,473	10,609	5,793	16,402	NA	NA	36.6
Keweenaw	86	NA	1,284	203	80	32	112	424	1.19	135.6
Lake	NA	0.07	7,461	1,025	798	103	901	NA	NA	45.8
Lapeer	NA	0.09	743	3,386	1,656	900	2,556	NA	NA	1.2
Leelanau	790	NA	4,172	2,508	1,192	702	1,894	151	6.43	60.9
Lenawee	NA	0.12	2,177	4,548	2,289	1,106	3,395	NA	NA	4.4
Livingston	NA	0.70	1,643	6,693	4,199	2,940	7,139	NA	NA	9.7
Luce	NA	NA	1,112	986	184	77	261	31	-	77.1
Mackinac	457	NA	4,039	1,802	597	352	949	298	7.15	132.1
Macomb	11,580	NA	527	18,525	12,104	13,514	25,618	27	12.46	2.7
Manistee	922	NA	3,196	2,152	806	348	1,154	25	3.17	38.5
Marquette	166	NA	4,079	4,826	1,585	506	2,091	79	0.31	54.4
Mason	560	NA	3,045	2,508	845	427	1,272	28	3.09	68.7

Appendix C (cont'd).

COUNTY	BOATING OPPORTUNITIES INDICES									
	GM[a]	LM[b]	SH[c]	RS[d]				GL[e]	CP[f]	TR[g]
				<16'	16'-20'	> 21'	>16'			
Mecosta	NA	0.35	3,273	2,601	1,102	537	1,639	NA	NA	9.9
Menominee	216	NA	1,727	1,701	540	208	748	41	0.79	20.1
Midland	NA	0.02	417	4,867	2,412	1,142	3,554	NA	NA	0.5
Missaukee	NA	0.08	2,413	1,103	648	165	813	NA	NA	5.8
Monroe	5,961	NA	292	4,354	2,988	2,214	5,202	57	0.97	5.8
Montcalm	NA	0.27	2,871	4,103	1,374	545	1,919	NA	NA	22.6
Montmorency	NA	0.37	4,873	1,430	283	241	524	NA	NA	11.2
Muskegon	2,499	NA	1,170	7,871	3,392	2,212	5,604	27	2.69	21.7
Newaygo	NA	0.40	5,057	3,639	1,528	643	2,171	NA	NA	48.0
Oakland	NA	2.52	2,556	32,873	23,082	16,647	39,729	NA	NA	13.8
Oceana	177	NA	3,504	1,659	555	279	834	27	1.05	28.1
Ogemaw	NA	0.17	5,678	1,838	856	325	1,181	NA	NA	39.1
Ontonagon	42	NA	1,222	872	236	65	301	56	0.09	58.8
Osceola	NA	0.04	3,328	1,565	547	124	671	NA	NA	5.0
Oscoda	NA	0.04	4,520	868	737	94	831	NA	NA	50.4
Otsego	NA	0.20	3,711	1,771	562	323	885	NA	NA	31.8
Ottawa	4,334	NA	1,728	10,728	4,996	3,688	8,684	25	4.53	11.8
Presque Isle	252	NA	3,044	1,716	535	337	872	69	2.33	39.6
Roscommon	NA	1.06	10,580	2,945	1,627	1,217	2,844	NA	NA	48.3
Saginaw	67	NA	202	8,907	4,510	2,425	6,935	-	0.02	0.3
Saint Clair	5,915	NA	1,921	5,952	3,450	3,472	6,922	164	8.52	11.8
Saint Joseph	NA	0.46	1,481	4,977	2,054	740	2,794	NA	NA	7.0
Sanilac	268	NA	3,479	1,104	607	342	949	41	2.19	15.9
Schoolcraft	39	NA	1,782	1,368	322	112	434	46	0.37	86.2
Shiawassee	NA	0.01	117	3,495	1,461	577	2,038	NA	NA	0.1
Tuscola	263	NA	743	2,362	1,269	712	1,981	20	0.02	13.4
Van Buren	1,054	NA	3,511	4,661	1,813	965	2,778	13	3.35	8.5
Washtenaw	NA	0.39	935	7,573	4,298	2,357	6,655	NA	NA	9.3
Wayne	7,613	NA	1,023	31,478	21,172	15,709	36,881	75	4.04	7.3
Wexford	NA	0.09	2,166	2,347	1,339	376	1,715	NA	NA	13.3

a. GM indicator: number of marina spaces in the county.

b. LM index: storage opportunity index for boats kept at marinas in inland counties.

c. SH indicator: number of second homes in the county.

d. RS indicator: number of registered boats in the county.

e. GL indicator: miles of Great Lakes shorelines in the county.

f. CP index: cruising opportunity index.

g. TR index: boating opportunity index for boats kept at nonwaterfront homes.

APPENDIX D

NUMBER OF BOAT DAYS GENERATED BY BOATS IN DIFFERENT STORAGE SEGMENTS IN DIFFERENT COUNTIES

Appendix D. Number of Boat Days Generated by Boats in Different Storage Segments in Different Counties.

	BOAT STORAGE SEGMENT				TOTAL
COUNTY OF STORAGE	Marina	Second Home	Waterfront Home	Nonwaterfront Home	
Southeast					
Macomb	300,077	15,815	217,687	175,897	709,475
Monroe	154,469	8,763	42,779	38,547	244,557
St Clair	153,277	57,647	59,725	52,048	322,697
Wayne	197,278	30,699	304,482	276,196	808,656
Central East					
Bay	111,809	4,298	13,414	59,388	188,909
Huron	53,874	67,031	4,047	18,028	142,980
Saginaw	3,488	2,655	20,871	98,426	125,440
Sanilac	13,950	45,726	2,703	12,642	75,021
Tuscola	13,690	9,765	5,725	26,803	55,984
Northeast					
Alcona	3,006	97,325	17,044	11,345	128,720
Alpena	6,904	31,429	30,907	22,077	91,317
Arenac	21,635	41,899	27,836	15,208	106,578
Cheboygan	21,695	83,885	34,653	23,348	163,581
Iosco	30,206	115,349	37,029	25,020	207,603
Presque Isle	7,499	52,856	18,839	13,354	92,548
Northwest					
Antrim	7,440	80,079	37,277	23,826	148,623
Benzie	24,716	53,642	25,792	17,205	121,355
Charlevoix	60,950	66,059	33,032	20,580	180,621
Emmet	23,833	74,741	36,299	23,125	157,998
Grand Traverse	11,938	56,218	92,603	58,480	219,239
Leelanau	33,207	71,159	36,093	22,989	163,448
Manistee	38,756	54,512	26,290	17,711	137,268
Mason	23,539	51,936	29,796	20,328	125,601
Central West					
Muskegon	52,613	22,666	29,139	94,241	198,659
Oceana	3,726	67,381	4,440	17,388	93,436
Ottawa	91,246	33,475	45,288	135,905	305,914
Southwest					
Allegan	20,358	22,663	57,713	52,555	153,289
Berrien	50,156	36,925	78,473	69,377	234,932
Van Buren	18,955	29,147	44,968	41,260	134,330
South Inland					
Barry	9,354	51,290	35,685	38,925	135,253
Branch	7,495	57,827	27,534	28,800	121,656
Calhoun	3,048	224	44,792	52,343	100,406
Cass	11,445	70,498	36,492	38,495	156,931
Clinton	57	1,030	25,900	28,327	55,313
Eaton	60	3,291	36,069	39,067	78,488
Genesee	1,713	17,664	143,750	143,565	306,691
Gratiot	206	2,373	14,519	16,322	33,420
Hillsdale	1,721	40,611	20,979	21,235	84,546
Ingham	31	7,746	72,943	78,029	158,750
Ionia	408	8,731	20,580	23,745	53,464
Isabella	268	20,888	17,814	19,530	58,499
Jackson	10,566	41,283	67,361	70,345	189,555
Kalamazoo	8,007	13,746	81,972	87,213	190,938
Kent	7,173	30,469	187,246	196,582	421,471
Lapeer	1,832	16,634	28,420	28,923	75,809
Lenawee	2,322	48,738	38,290	38,735	128,085
Livingston	13,909	36,783	69,646	63,386	183,724
Midland	427	9,336	40,454	41,216	91,433
Montcalm	5,268	64,275	26,345	31,539	127,426
Oakland	49,891	57,223	373,912	325,217	806,243

Appendix D (cont'd).

COUNTY OF STORAGE	BOAT STORAGE SEGMENT				TOTAL
	Marina	Second Home	Waterfront Home	Nonwaterfront Home	
St Joseph	9,126	33,156	35,768	39,645	117,695
Shiawassee	112	2,619	25,541	28,066	56,338
Washtenaw	7,638	20,932	70,412	67,483	166,465
North Inland					
Clare	2,410	91,716	30,906	25,244	150,277
Crawford	561	43,307	21,719	13,515	79,101
Gladwin	1,958	60,797	36,320	24,725	123,801
Kalkaska	1,689	38,369	18,495	14,985	73,538
Lake	923	82,595	15,664	11,416	110,597
Mecosta	4,893	36,233	34,399	26,698	102,222
Missaukee	1,146	26,712	15,512	11,735	55,106
Montmorency	5,094	53,945	14,933	13,356	87,327
Newaygo	5,465	55,982	46,474	36,924	144,845
Ogemaw	2,373	62,857	24,317	18,946	108,493
Osceola	497	36,842	16,754	14,959	69,051
Oscoda	587	50,037	13,970	9,906	74,501
Otsego	2,824	41,081	20,947	17,368	82,221
Roscommon	14,666	117,123	51,252	33,695	216,735
Wexford	1,295	23,978	32,958	24,919	83,150
South Upper Peninsula					
Delta	5,664	59,922	25,855	17,191	108,632
Dickinson	0	41,960	18,748	12,502	73,211
Iron	0	64,195	13,828	8,987	87,010
Mackinac	11,555	100,342	17,263	10,942	140,102
Menominee	5,461	42,904	14,709	9,613	72,688
Schoolcraft	986	44,271	10,648	6,920	62,825
North Upper Peninsula					
Alger	1,844	12,917	12,235	4,351	31,347
Baraga	10,019	7,939	7,061	2,617	27,636
Chippewa	27,107	33,279	34,078	12,967	107,431
Gogebic	2,520	17,588	19,228	6,748	46,085
Houghton	9,650	16,803	22,940	8,811	58,205
Keweenaw	5,286	8,926	2,449	935	17,596
Luce	0	7,731	10,137	3,381	21,249
Marquette	10,204	28,357	54,779	19,885	113,224
Ontonagon	2,582	8,495	9,427	3,278	23,782
State Total	1,845,629	3,360,812	3,625,375	3,457,550	12,289,366

APPENDIX E

NUMBER OF BOAT DAYS IN STORAGE REGIONS AND DESTINATION REGIONS BY BOATS IN DIFFERENT STORAGE SEGMENTS

Appendix E. Number of Boating Days in Storage Regions and Destination Regions By Boats in Different Storage Segments.

Boat Days (000's)	STORAGE REGIONS										Total
DESTINATION REGIONS	South East	Central East	North East	North West	Central West	South West	Inland South	Inland North	UP South	UP North	
Southeast	**1,791.0**	**12.5**	**2.2**	**2.8**	**3.8**	**2.0**	**75.8**	**0.3**	**0.2**	**0.5**	**1,891.1**
Marina	745.4	8.9	2.2	2.8	3.8	1.8	-	-	0.2	0.5	765.6
Second home	112.9	-	-	-	-	-	-	-	-	-	112.9
Waterfront Home	624.7	-	-	-	-	-	-	-	-	-	624.7
Nonwaterfront Home	308.0	3.6	0.0	-	0.1	0.2	75.8	0.3	-	-	388.0
Central East	**23.4**	**463.0**	**1.3**	**1.1**	**1.1**	**2.5**	**55.4**	**1.8**	**0.0**	**0.1**	**549.8**
Marina	14.1	160.0	0.9	0.5	0.7	0.3	-	-	0.0	0.1	176.7
Second home	-	129.5	-	-	-	-	-	-	-	-	129.5
Waterfront Home	-	46.8	-	-	-	-	-	-	-	-	46.8
Nonwaterfront Home	9.2	126.8	0.4	0.6	0.5	2.2	55.4	1.8	0.0	-	196.8
Northeast	**17.6**	**31.3**	**776.3**	**3.8**	**4.9**	**1.9**	**47.8**	**8.0**	**0.3**	**0.7**	**892.6**
Marina	6.5	8.1	82.2	1.5	1.5	0.7	-	-	0.1	0.2	100.7
Second home	-	-	422.7	-	-	-	-	-	-	-	422.7
Waterfront Home	-	-	166.3	-	-	-	-	-	-	-	166.3
Nonwaterfront Home	11.0	23.2	105.0	2.3	3.4	1.2	47.8	8.0	0.2	0.5	202.8
Northwest	**29.4**	**17.0**	**3.9**	**1,230.9**	**12.1**	**8.5**	**62.8**	**15.4**	**0.7**	**0.8**	**1,381.6**
Marina	18.7	9.5	3.0	215.4	4.4	2.0	-	-	0.3	0.5	253.8
Second home	-	-	-	508.3	-	-	-	-	-	-	508.3
Waterfront Home	-	-	-	317.2	-	-	-	-	-	-	317.2
Nonwaterfront Home	10.7	7.5	1.0	190.0	7.6	6.5	62.8	15.4	0.5	0.3	302.2
Central West	**12.0**	**3.6**	**0.7**	**2.7**	**514.6**	**6.2**	**34.2**	**6.5**	**0.1**	**0.1**	**580.8**
Marina	5.4	2.7	0.7	1.8	128.4	1.5	-	-	0.1	0.1	140.7
Second home	-	-	-	-	124.0	-	-	-	-	-	124.0
Waterfront Home	-	-	-	-	78.9	-	-	-	-	-	78.9
Nonwaterfront Home	6.6	0.9	0.0	0.9	183.4	4.7	34.2	6.5	-	-	237.2
Southwest	**6.8**	**2.5**	**0.5**	**0.8**	**12.2**	**465.4**	**51.8**	**0.3**	**0.1**	**0.1**	**540.4**
Marina	3.9	2.0	0.5	0.6	6.3	81.9	-	-	0.1	0.1	95.5
Second home	-	-	-	-	-	88.7	-	-	-	-	88.7
Waterfront Home	-	-	-	-	-	181.2	-	-	-	-	181.2
Nonwaterfront Home	2.9	0.5	0.0	0.2	5.8	113.6	51.8	0.3	-	-	175.1

Appendix E (cont'd).

Boat Days (000's)	STORAGE REGIONS										Total
DESTINATION REGIONS	South East	Central East	North East	North West	Central West	South West	Inland South	Inland North	UP South	UP North	
Inland South	**114.1**	**12.2**	**0.1**	**0.9**	**13.3**	**28.2**	**3,408.0**	**3.3**	**0.0**	-	**3,580.0**
Marina	-	-	-	-	-	-	152.1	-	-	-	152.1
Second home	-	-	-	-	-	-	657.4	-	-	-	657.4
Waterfront Home	-	-	-	-	-	-	1,542.4	-	-	-	1,542.4
Nonwaterfront Home	114.1	12.2	0.1	0.9	13.3	28.2	1,056.1	3.3	0.0	-	1,228.1
Inland North	**43.3**	**30.6**	**3.0**	**5.7**	**12.8**	**5.6**	**108.5**	**1,483.6**	**0.3**	**0.1**	**1,693.6**
Marina	-	-	-	-	-	-	-	46.4	-	-	46.4
Second home	-	-	-	-	-	-	-	821.6	-	-	821.6
Waterfront Home	-	-	-	-	-	-	-	394.6	-	-	394.6
Nonwaterfront Home	43.3	30.6	3.0	5.7	12.8	5.6	108.5	221.1	0.3	0.1	431.0
UP South	**15.2**	**8.4**	**1.4**	**2.2**	**9.7**	**1.0**	**23.9**	**6.0**	**538.5**	**5.1**	**611.4**
Marina	6.2	3.1	0.8	1.0	1.4	0.7	-	-	22.7	1.6	37.5
Second home	-	-	-	-	-	-	-	-	353.6	-	353.6
Waterfront Home	-	-	-	-	-	-	-	-	101.1	-	101.1
Nonwaterfront Home	9.0	5.3	0.6	1.2	8.3	0.3	23.9	6.0	61.2	3.4	119.2
UP North	**32.8**	**7.2**	**0.9**	**3.2**	**13.4**	**1.2**	**30.4**	**35.8**	**4.2**	**439.0**	**568.1**
Marina	4.9	2.5	0.6	0.8	1.1	0.5	-	-	0.2	66.0	76.6
Second home	-	-	-	-	-	-	-	-	-	142.0	142.0
Waterfront Home	-	-	-	-	-	-	-	-	-	172.3	172.3
Nonwaterfront Home	28.0	4.8	0.2	2.4	12.3	0.7	30.4	35.8	4.0	58.6	177.1
TOTAL	**2,085.4**	**588.3**	**790.3**	**1,254.2**	**598.0**	**522.6**	**3,898.6**	**1,561.0**	**544.5**	**446.6**	**12,289.4**
Marina	805.1	196.8	90.9	224.4	147.6	89.5	152.1	46.4	23.7	69.2	1,845.6
Second home	112.9	129.5	422.7	508.3	124.0	88.7	657.4	821.6	353.6	142.0	3,360.8
Waterfront Home	624.7	46.8	166.3	317.2	78.9	181.2	1,542.4	394.6	101.1	172.3	3,625.4
Nonwaterfront Home	542.7	215.3	110.4	204.2	247.5	163.2	1,546.7	298.4	66.2	63.0	3,457.6

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