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METHODOLOGY AND FORECASTS OF RECREATION USE AND SMALL CRAFT  
LOCKAGES ON THE UPPER MISSISSIPPI RIVER

VOLUME I

FINAL REPORT  
July 26, 1978

Contract No. DACW 37-77-C-0075  
MRI Project No. 4387-D

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## PREFACE

This report contains the findings, conclusions and recommendations for the Upper Mississippi Recreation Use and Small Craft Lockage study. Throughout the study, MRI worked closely with the St. Paul District. Some of the important study benchmarks included: the initial presentation in St. Paul recommending the recreation lockage survey, the subsequent survey which was conducted during the months of July and August, the public participation workshops held at three key cities along the Mississippi River, and finally a presentation of MRI's findings, conclusions and recommendations.

Volume II of this report contains the appendices which document the multiple regression analysis and gravity model utilized to forecast potential marina markets for the Mississippi River. Appendix E contains the documentation for the forecasting model itself. It is anticipated this model will continue to undergo revision as data coefficients and other important variables affecting lockage are studied.

The project director for this study was Mr. Raymond M. Mischon. The survey instrument was designed and supervised by Mrs. Greta O'Keefe and Ms. Cheryl Fellhauer. Because of the statistical techniques and computer analyses utilized in this study, several individuals were involved at various stages. Mr. Leroy Adams, Senior Computer Specialist, and Mr. Mike Sharp, Senior Statistician, performed the regression analysis and assisted in developing the forecasting model. Mr. Jim Miller, Consultant in Computer Science, supervised preparation of the survey data and provided all analyses of the data. Mr. Barry Sanders, also Consultant in Computer Science, provided assistance in the gravity analysis. The on-site recreation lockage survey was accomplished by four college students from the Kansas City area. These were Messrs. John Bingham, Paul James, Ray Mischon, Jr., and Graham Wheeler.

Special thanks go to Mr. Jim Holleran, Outdoor Recreation Planner, and Mr. Don Wadleigh, Water Resources Planner, both with the St. Paul District; also to Mr. Dave Arndorfer of Roy F. Weston, Inc., who supplied data from the Lake Superior Boating Survey.

Many other Corps staff from the St. Louis, Rock Island, and St. Paul districts assisted in collecting and providing interpretation of data. It has been a pleasure being a part of this benchmark study, and we are certain that the results will have long-lasting benefits in planning facilities and services for recreation craft on the Mississippi River.

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## CHAPTER I

### INTRODUCTION

Because of increasing lockage pressure on the Mississippi River between the Twin Cities and St. Louis, Missouri, Congress authorized the Corps of Engineers to conduct the Upper Mississippi River Recreation Craft Locks study:

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River between the mouth of the Missouri River and Minneapolis, Minnesota, printed in House Document No. 137, 72nd Congress, 1st Session, and other pertinent reports with the view to determining whether it is advisable in the interest of navigation to modify the existing navigation project on the Upper Mississippi River to provide for separate locks or other means to permit independent passage of recreation craft in view of the needs and safety of the present and anticipated heavy volume of small craft utilizing this waterway."<sup>1/</sup>

The overall study provided for investigation of the problems encountered by recreation boaters traveling along the Mississippi River. It was also to focus on the feasibility and economic justification of providing independent passage of recreation craft at locks and dams. To establish priorities, the overall study effort was to examine at which locks an independent means of passage might be needed.

As a part of this total study, MRI was asked to document the present level of usage and develop a model and forecasts for recreation use and lockage. Specifically, the objectives of this study were:

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<sup>1/</sup> Recreation Craft Locks Study, Plan of Study (Upper Mississippi River), U.S. Army, Corps of Engineer Districts--St. Paul, Rock Island, and St. Louis, February 1977.

- To develop methodology to forecast recreation use and small craft lockage on the Upper Mississippi River; and
- To forecast recreation use and craft lockage for 1980, 1985, 1990, 1995, and 2000.

The study area for the MRI project extended from the Twin Cities in Minnesota to just north of the confluence of the Missouri River with the Mississippi, north of St. Louis, Missouri (see Figure 1). The Mississippi River between these points includes 28 lock and dam operations and a variety of resources ranging from numerous islands and relatively clear water and sand beach conditions in the north, to muddier conditions and a larger river base to the south. The primary influence area for general recreation use on the river is approximately 80 miles either side of the Mississippi, or approximately 2 hours distance from the river. This market area differs somewhat from the zone of influence for river boaters described later in this report.

It was anticipated there would be major data gaps to fill in order to complete the study. For that reason, the study was divided into two phases. The first phase was devoted to evaluating the quality and quantity of available data and recommending data collection necessary to complete the study. At the conclusion of Phase I, a presentation of findings was made to the St. Paul District. As a result of that meeting and further negotiation, an interview survey was considered necessary and was conducted of recreation lockage users during a portion of the summer (1977). The results of this survey are contained in this report. The methodology to forecast small craft lockage described in this report incorporates data from that survey.

To develop the forecasting methodology, MRI utilized multiple regression techniques and a gravity model to forecast potential marina markets in the 28 pools of the Upper Mississippi River. These statistical tools are fully documented in the appendices of this report so that the St. Paul District may update coefficients and modify the forecasts as new data become available.

The MRI study is summarized in Volume I. The report contains six chapters. The chapter titles are listed below:

Chapter I - Introduction

Chapter II - Executive Summary (Findings, Conclusions,  
and Recommendations)

Chapter III - Literature Review and Data Sources

Chapter IV - Recreation Lockage User Characteristics  
(Discussion of the Summer 1977 Recreation Lockage Survey)

Chapter V - Methodology and Forecasts of Small Craft  
Lockages

Chapter VI - Methodology and Forecasts of Recreation Use

Chapter VII - Recommendations for Future Research



Figure 1 - Locks and Dams on the Upper Mississippi River

## CHAPTER II

### EXECUTIVE SUMMARY

The overall objective of the recreation lockage study was to document the present level of usage and develop a model and forecasts for general recreation use and, in particular, recreation boat lockage. Specific tasks in this study were to:

- Develop a methodology to forecast use and small craft lockages on the Upper Mississippi River;
- Forecast use and small craft lockages for 1980, 1985, 1990, 1995, and 2000.

The study area extended from the Twin Cities in Minnesota to just north of the confluence of the Missouri River with the Mississippi north of St. Louis, Missouri. This section of the river contains 28 lock and dam operations and a variety of land and water resources. Outlined below are MRI's overall research approach, findings and recommendations for further study.

#### A. Research Approach

It was learned early in the study that there was a lack of meaningful data to describe recreation use and small craft lockage on the Mississippi River. From these limited data, MRI came to the following initial conclusions.

- Lockage trends are not well established for the entire river, by district, or at individual facilities.
- Lack of established trends probably indicates a number of factors are involved in determining recreation lockage.
- Several locks appear to be experiencing high rates of growth in recreation lockage, while the bulk of the remaining locks are either varying from year to year or remaining relatively constant.

Because of the lack of meaningful data related to small craft lockage, MRI proposed that a survey of lockage users be conducted during the summer. This survey provided a limited perspective of their use patterns. The general research methodology is described below:

1. Recreation Lockage Survey: To obtain an overall perspective of recreation lockage use, a survey of boaters was conducted at a sample of locks on the Upper Mississippi River. A total of 1,464 usable questionnaires were obtained. Over 70 percent were obtained between noon and 5:00 in the afternoon. Over half of the questionnaires came from locks under the jurisdiction of the St. Paul District. The survey period was from July 1 through August 15, 1978.

2. Recreation Use Analysis: Because of limited time and funds available, MRI was unable to conduct a broader population survey to determine the role the Mississippi River plays in overall river recreation use patterns. As an alternative, MRI developed three separate methods to forecast recreation use along the Upper Mississippi River. These forecasts were grouped into river use zones and compared to RRMS trends.

3. Recreation Lockage Analysis: Multiple regression analysis was utilized to explore the relationship between various use and resource factors and small craft lockages. The independent variables included:

- Commercial marina slips (a surrogate of boating activity).
- Long-distance flow factors (boat movement).
- Commercial lockages.
- Distance between the locks.
- Recreation quality of the pools.

## B. Findings

Major findings are summarized below:

1. Lockage Survey: Because the lockage survey was limited to a portion of the summer period, it must be emphasized that the characteristics described below are also limited to the summer season. Characteristics could be significantly different in the spring and fall of the year.

Over two-fifths of all recreation craft using Upper Mississippi River locks are of the runabout class; about one-third are some type of cruiser with overnight facilities; and nearly 16 percent are of the houseboat class. Few fishing boats (less than 3 percent) are presently using the locks. There was a slight difference in the types of craft, depending on the section of the river. The southern section of the river (below Lock 10) had more cruisers and fewer runabouts using the locks. It was noted also that the distance traveled on the river by type of craft varied widely. The runabouts, because of their limited overnight accommodations, tended to travel shorter distances than did cruisers and houseboats. Fishing boats tended to travel the shortest distance on the river. Because of the boating craft composition, the southern section of the river tended to have boaters traveling longer distances and using more locks.

Nearly half of all lockage users indicate they live in or within 10 miles of the town of their home marina or launching point. Seventy percent are located within 50 miles, 83 percent within 100 miles. In general, this market area compares very closely to what MRI has found in other midwestern lake and river studies.

The bulk of all recreation users (52.4 percent) indicated they were on a trip of 3 days or more. Less than one-third were on a day outing. In addition, one-third of the lockage users said they are traveling in a group with other boats. Nearly half of all lockage users say they make a similar type of trip at least 1 to 5 times per summer; 44 percent go on a similar type trip 6 to 20 times, and 8 percent, 21 or more times per summer.

The most popular recreation activity pursued by recreation lockage users is swimming. Picnicking and camping are also popular. All of these activities were participated in by more than two-thirds of the lockage users. A total of 38 percent of the groups indicated they camped on dredge-material islands. Other boaters said they camped on their boats at commercial marinas. About one-fourth of the lockage users fished during their river experience.

In general, lockage users were pleased with the overall operation of the locks. Nearly two-thirds considered the service either excellent, good or satisfactory. There were complaints about barge traffic and lockage delays, however. Fourteen percent of the lockage users made comments about excessive delays or various types of barge complaints; nearly 8 percent indicated a need for auxiliary locks.

By cross-tabulating survey responses, it was learned that boats which are seasonally moored are responsible for most of the lockage. These findings seem to imply that there will continue to be extreme peaking of recreation lockage during weekends and holidays near major river-oriented metropolitan areas. Not only are a large number of boats moored near a few locks close to metropolitan areas, but weekend boating enthusiasts with small craft do not stray far from their home berth on short weekend trips. Recreation lockage along the more rural sections of the Mississippi River will continue to be more balanced (i.e., recreation lockage occurring during all times of the day and week because of longer distance traffic from major metropolitan areas en route to recreation destinations).

2. Lockage Forecasting Model: Multiple regression analysis showed that five factors provide a correlation R-value of 0.8253, or 68 percent of the variation in the Y-values (pleasure boats through the locks). These variables included the long distance flow factor (derived from the survey), the number of commercial marina slips above and below each pool, the number of commercial lockages, the quality of the resources in the pools and the average distance between the locks.

Using the coefficients developed in the regression analysis, a lockage forecast was developed. A gravity model was used to estimate future potential commercial marina slippage for each pool. This variable replaced the actual number of commercial marina slips in the regression analysis and forecast slippage for 5 years (1980, 1985, 1990, 1995, and 2000). The St. Paul District provided forecasts of commercial lockage for the 5 years. Estimates of the number of pleasure boats through the locks were then computed for the future at each of the 28 locks. A second correlation analysis between pleasure boats through the locks and actual recreation lockages for the past 6 years showed a correlation of 0.97 (R-value). This regression equation was interfaced with the previous equation to develop estimates of recreation lockages for the 5 forecast years and for 28 locks on the Upper Mississippi River. Three locks required the development of a unique factor to convert pleasure boats through the locks to the number of recreation lockages.

3. Lockage Forecasts: Utilizing the two regression equations, including the forecasts of future slippage and commercial lockage, projections of pleasure boat lockages were made for 1980, 1985, 1990, 1995, and 2000. The pattern of recreation lockage through the year 2000 is presented in Table 25. These projections show some interesting future lockage patterns. For example, a number of locks show little or no increase. These include the Upper and Lower St. Anthony Falls, Locks 5, 5A, 6, 8, 9, 10, 12, 16, 17, 18, 19, 20, 21, and 26. Sharp decreases are shown for Locks 22 and 24. Increases in future lockage seem to center around major metropolitan areas. For example, increases are forecast for the locks between 1 and 4. A moderate increase is also projected for Lock 7 (La Crosse, Wisconsin). Increases are also forecast for Locks 13, 14, and 15 around the Quadcities area of Illinois and Iowa. And finally, a large increase is projected for Lock 25.

Specific model increases for individual locks should be viewed with some caution. For example, although Lock 25 is projected to increase five times over the 1977 rate, realistically it can be expected that a part of this increase will be distributed between Locks 24 and 26. Because of the large increase in commercial lockage forecast for Lock 26, the model constrained that lock to receive only a small portion of the recreation lockage for the entire St. Louis area. On the other hand, the present slip capacity of Lock 24 is small compared to other locks on the Upper Mississippi River. Realistically, if the population and boat registration in the St. Louis area increases as is projected, then in all probability recreation lockage at both Locks 24 and 26 will exceed model forecasts.

A similar pattern will no doubt result at the upper end of the Mississippi around Locks 1 through 4. As can be noted, the largest increase is projected for Lock 1. The forecasts decrease down to about 1-1/2 times the 1977 rate for Lock 4. Since the model is constructed so that the closest lock is allocated more slippage than more distant locks, the pattern obviously shows a larger increase for the locks closest to the Minneapolis/St. Paul area.

The lockage model forecast seem to be directly in line with the findings of the 1977 lockage survey. The survey indicated that the key locks for recreation lockage peaking would be those located near metropolitan areas. The model forecasts such a pattern, with major increases expected for the Minneapolis/St. Paul area, La Crosse, Wisconsin, the Quadcities area, and the St. Louis area.

C. Recommendations (also see Chapter VII)

1. Determine Long-Term Forecasting Power of the Lockage Forecasting Model: Since the regression analysis applies only to the year of 1977, it is recommended that the analysis be tested for 1978 and subsequent years. As other data become available, such as updated slip inventories, long distance flow factors, and other measures of resource quality, etc., these variables should be introduced into the model to determine whether or not it has long-term forecasting power.

2. Continued Monitoring of Lockage Traffic: Since the forecasting model utilizes long-distance flow factors, and the lockage study provides a flow factor for only the summer of 1977, it is recommended that lockage traffic be continually monitored to determine major changes in use characteristics. This could be accomplished by a simple postcard questionnaire passed to lockage users as they lock through. These cards could then be interfaced with a major survey, such as the one conducted this summer, approximately every 5 years.

3. Documentation of Recreation Use and Future Methodologies: A major problem in this study was in obtaining usable data for development of a recreation lockage forecasting model. It is recommended that attention be focused on documenting actual recreation use of each pool, particularly water-related use. At the same time, the Corps should also give attention to the development of a systems model incorporating various recreation use factors for determining future recreation activity. This model should take into consideration the competitive effects of other water resources. To find answers to some of the more basic questions regarding user perceptions of lockage, the Corps of Engineers should conduct a survey of registered boaters in the market area immediately surrounding the Upper Mississippi River.

## CHAPTER III

### LITERATURE REVIEW AND DATA SOURCES

The purpose of a literature review is to evaluate pertinent research and gain a better understanding of how those findings may apply to a specific scope of study. During this phase, MRI examined the availability of data from State Comprehensive Outdoor Recreation Plans (SCORPs), various Corps of Engineers regulations, manuals, guidelines, etc., and other studies having some relationship to the general scope of study.

Some of the major sources of information included:

- Computerized Literature/Research System.

- \* National Technical Information Service (NTIS).
- \* Transportation Research Information System (TRIS).
- \* Smithsonian Science Information Exchange (SSIE).

- State data for the five study area states.

- \* Most recent State Comprehensive Outdoor Recreation Plan supply/demand data.
- \* Characteristics and visitation to state recreation areas (1970 to 1976).
- \* Total boat registration by county.
- \* Population projections by county.
- \* Other recreation research studies by universities, etc.

- Corps of Engineers data sources.

- \* RRMS (Recreation Resource Management Statistics) visitation data by pool (1970 to 1977).
- \* Total recreation/commercial lockage by pool (1970 to 1977).

\* Detailed characteristics of recreation lockages from PMS (Performance Monitoring System of INSA) data collection systems (1976).

The overall findings of the literature review were presented in St. Paul at the conclusion of Phase I. These findings are summarized below:

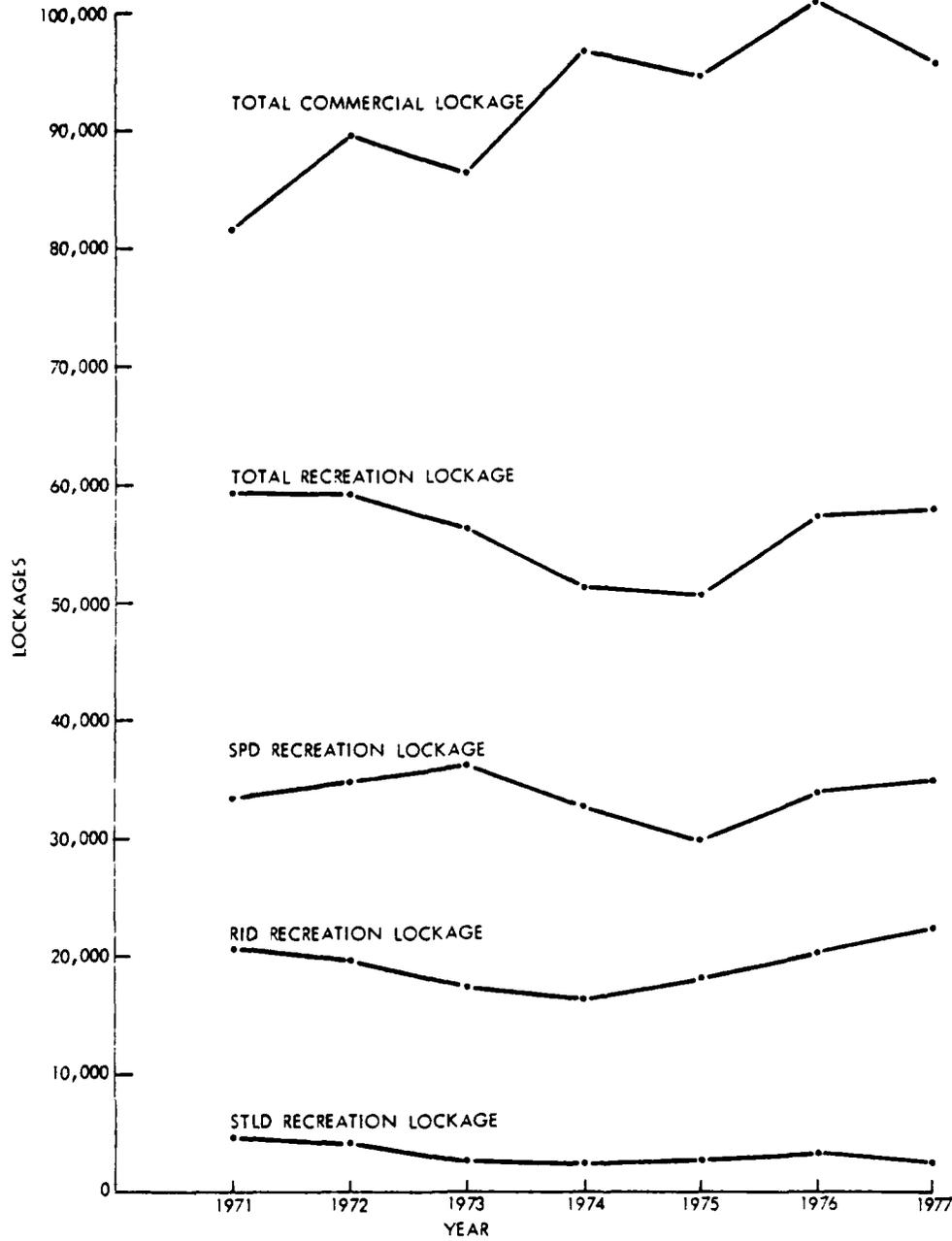
#### A. Initial Research Findings

1. General Lockage Trends: Figure 2 provides a graphic picture of the trends in both commercial and recreation lockage for the past 7 years. In general, commercial lockage is continuing to trend slightly upward through 1977. On the other hand, recreation lockage appears to vary by district. St. Paul District lockage, for example, trended upward through 1973, then downward through 1975, and then again upward through 1977. The Rock Island District lockage was down through 1974 but has been up for the last 3 years. The St. Louis district lockage has been almost constant for the past 7 years.

Two factors were pointed out in MRI's initial presentation in St. Paul that could impact heavily on the amount of lockage occurring by district, by year. First, the land and water resources vary considerably. Clean water and sand bars dominate the upper part of the Upper Mississippi, whereas rather muddy conditions and a poor shoreline prevail on the lower end of the Upper Mississippi. Secondly, flooding conditions over the past several years may have contributed to a decrease in recreation lockage from previous peaks.

Recreation trends at individual locks reflect a striking resemblance to the pattern followed by the respective district totals. Locks in the St. Paul District that showed increases in recreation traffic in 1972 dropped off in volume in 1973, and vice versa. Table 1 indicates that the increased volume in 1972 was concentrated around Locks 5 through 10, whereas those same locks (with the exception of Lock 10) decreased in volume in 1973. The losses were not great enough to negate gains at the two St. Anthony Falls Locks and Locks 1 through 4. All locks in the St. Paul District recorded decreases in lockage volume in both 1974 and 1975 (except Lock 10 which gained in 1974); but all, with the exception of Locks 2 and 4, were back up in 1976. A review of the last three columns of Table 1 suggests that by 1976 only around half of the locks in the St. Paul District surpassed the lockage volume of 1971; they were Locks 2, 3, 5, 6, 7, 9, and 10. From among those locks with greater volume in 1976 than in 1971,

# LOCKAGE ON THE UPPER MISSISSIPPI RIVER (1971 through 1976)



Source: Corps of Engineers

Figure 2

TABLE 1

LOCKAGE TREND BY YEAR

<u>Lock Number</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>Number in 1971</u>	<u>Peak Lockages</u>	<u>Number in 1977</u>
<u>St. Paul District</u>									
USAF	-	+	-	-	+	+	1,209	1,296 ('73)	943
LSAF	-	+	-	-	+	+	1,226	1,287 ('73)	940
1	-	+	-	-	+	+	1,783	2,056 ('73)	1,622
2	0	+	-	0	-	+	2,359	2,652 ('73)	2,570
3	-	+	-	-	+	+	3,282	3,852 ('77)	3,852
4	-	+	-	-	-	+	3,613	3,613 ('71)	3,027
5	+	-	-	0	+	+	2,476	2,653 ('72)	2,495
5A	0	-	-	-	+	-	3,809	3,809 ('71)	3,478
6	+	-	-	-	+	-	2,641	3,312 ('72)	2,931
7	+	-	-	0	+	-	3,307	4,164 ('72)	2,544
8	+	-	-	-	+	+	2,518	2,940 ('72)	2,594
9	+	-	-	-	+	+	2,415	2,638 ('72)	2,599
10	+	+	+	-	+	+	2,986	4,397 ('77)	4,397
<u>Rock Island District</u>									
11	+	-	0	+	+	+	2,137	2,658 ('77)	2,658
12	0	-	-	0	+	+	2,060	2,354 ('77)	2,354
13	-	+	-	+	+	-	2,010	2,183 ('76)	2,178
14	-	0	-	+	+	-	3,432	3,432 ('71)	3,101
15	0	-	+	+	+	-	2,807	2,929 ('76)	2,818
16	-	-	-	+	+	-	1,311	1,331 ('76)	1,310
17	-	-	-	-	+	+	1,249	1,270 ('77)	1,270
18	-	-	-	+	-	-	1,913	1,913 ('71)	1,418
19	-	-	0	+	0	-	824	824 ('71)	667
20	+	-	0	+	+	+	821	870 ('72)	705
21	0	-	+	+	+	+	1,092	1,092 ('71)	980
22	-	-	-	+	+	-	995	995 ('71)	776
<u>St. Louis District</u>									
24	-	-	0	+	+	+	1,248	1,248 ('71)	895
25	-	-	+	+	+	-	1,606	1,606 ('71)	1,128
26	0	-	0	-	-	-	944	969 ('72)	329

Legend: + Increase  
 - Decrease  
 0 Stable

none had recouped peak year lockage volume except Lock 10. The increase in lockage at Lock 10 continued in 1977, and all other locks except 5A, 6 and 7 increased over the 1976 lockage figure; Lock 3 peaked at 3,852 for the 7 years.

Locks 11 through 22, under the jurisdiction of the Rock Island District, exhibited losses or no growth in recreation lockages for the years 1972, 1973, and 1974. Table 1 clearly shows that the trend in 1975 and 1976 was up at all locks. A few exceptions include no growth at Lock 12 in 1975, a further drop in lockages at Lock 17 in 1975, and both a decline at Lock 18 and a leveling off at Lock 19 in 1976. Lockages in the Rock Island District clustered around those locks exhibiting the greatest volume for the 7-year period in 1971 (Locks 14, 18, 19, 21, and 22) and those reaching a volume high in 1976 (Locks 13, 15, and 16) and 1977 (Locks 11 and 12). A volume high was reached at Lock 17 in 1977; after 4 years of decline, lockage has been on an increase for the last 2 years at this lock. Overall lockage increased slightly in 1977 for the Rock Island District, with increases at five locks and decreases at seven locks.

Following the trend of the lower locks in the Rock Island District were Locks 24, 25, and 26 in the St. Louis District. In 1972, 1973, and 1974 the numbers of recreation lockages declined or were stable. In 1975 and 1976, volume picked up at Locks 24 and 25 while continuing to decrease at Lock 26. In 1977, lockage increased at Lock 24 and decreased at Locks 25 and 26. Volume highs for the study period were recorded in 1971 at Locks 24 and 25 and in 1972 at Lock 26.

The greatest variations in numbers of recreation lockages at the locks on the Upper Mississippi River were exemplified by Lock 4 which recorded a decline of 1,465 lockages between 1971 and 1976, and Locks 10 and 11 which recorded volume increases of 1,411 and 521 lockages, respectively, between 1971 and 1977.

2. Initial Conclusions: In light of available lockage data, MRI came to the following conclusions:

- Trends are not well established for overall lockage, lockage by districts, or lockage at individual facilities. There is neither a strong upward or downward trend in recreation lockage.

- Lack of trends probably indicates a number of factors affect recreation lockage on the Upper Mississippi River. These factors probably vary by pool and lock; thus no strong trends are observed.
- It appears that lockage varies by individual lockage facility. On the Upper Mississippi, Locks 10 and 11 stand out as facilities that are experiencing high rates of growth in recreation lockage. Lockage at the lower end of the Upper Mississippi River appears either to have stabilized or to continue to decline.

## B. Lockage and Recreation Use Data Sources

### 1. Available Data Sources

a. Dedicated Lockage Study: The St. Paul District Navigation Section has evaluated the effect of setting aside definite time periods when recreation traffic has limited priority for use of locks. To evaluate this program, they used a mail-back questionnaire distributed to recreation lockage users during one season. So far, the Dedicated Lockage Program has been limited to Locks 2 and 7 in the St. Paul District and Lock 19 in the Rock Island District. In addition, the auxiliary chambers of Locks 14 and 15 are generally reserved for recreation traffic during peak periods of use (see Figure 1 for location of the locks).

After examining these data, MRI came to the following initial conclusions:

- Eighty to 95 percent of the recreation lockage users come from within 50 miles of the river.
- Lock 2 - Lockage at this facility appears to be a one-lock trip, possibly resulting from people mooring their boats in Pool 2 and then utilizing the St. Croix River for their recreation experience.
- Lock 7 - Lockage at this facility appears to result from people traveling down the river on a several-lock trip.

b. GREAT<sup>1/</sup> Studies: The work of the GREAT has included several important studies:

1/ Great River Environmental Action Team.

(1) Demand Study: The recreation projections provided by the GREAT demand study are for the St. Paul District pools only. Although the study is admittedly based on limited data, it nevertheless provides some of the few projections available on recreation demand on the Upper Mississippi River.

(2) GREAT Aerial Survey: On Labor Day of 1976, the GREAT sponsored an aerial flight of the Upper Mississippi River. That survey was utilized to count the number of recreation boats in open water, as well as those using the dredge spoil area. To test a relationship between the amount of boating use and lockage, the number of boats on each pool and the recreation lockage that day were examined (see Table 2). Boating use that day was also compared to the total recreation lockage for 1976.

TABLE 2

RELATIONSHIP--BOATING USE/LOCKAGE  
(GREAT Aerial Survey--1976)

<u>Pool</u>	<u>Boating Use</u> <u>(9/5/76)</u>	<u>Recreation Lockage</u> <u>(9/5/76)</u>	<u>Recreation Lockage</u> <u>(1976)</u>
1	6	12	1,502
2	154	30	2,482
3	169	48	3,671
4	430	40	2,148
5	83	41	2,494
5A	120	56	3,596
6	132	51	2,984
7	156	54	3,585
8	310	29	2,449
9	337	29	2,421
10	570	43	3,624

Close inspection of this table shows little relationship between 1-day boating count (boating use) and recreation lockage for Labor Day. For example, the most heavily used locks on Labor Day (September 5, 1976) were: Locks 5A, 7, and 6. However, the most boats counted on a pool occurred on Pools 10, 4, and 9. The heaviest lockage in 1976 occurred at Locks 3, 10, 5A, and 7.

It should be noted that the aerial survey team had great difficulty in locating boats, and that this survey only documented use for one point in time (approximately 2 hours of an entire recreation season). The aerial survey was verified by some ground truthing, however; and the methodology does provide some potential for estimating future visitation on the Upper Mississippi River. It appears that the methodology will have to be studied further, and no doubt, the frequency of flights will have to be increased before the data will be of statistical value in estimating recreation use and developing any type of meaningful correlation with recreation lockage.

(3) Supply Inventory: As another possibility, the relationship between the number of marina boat slips available on each pool and the total recreation lockage for 1977 at each lock and dam operation was examined. The number of slips available was taken from the recent GREAT supply inventory. The relationship here appeared stronger (see Table 3). For example, Locks 3 and 10 have the highest lockage on the Upper Mississippi River. If the total slippage available on Pools 2, 3, and 4 is added to the number of slips on the Lower St. Croix River, it may be noted that nearly 3,400 marina slips are concentrated in a rather small area. This is the heaviest concentration of marina slippage on the Upper Mississippi River. Lock 3 also had the largest number of recreation lockages in 1976. In terms of total slippage available, Pool 10 has 785. However, Lock 9 has 909 and Lock 13 has 1,077. If all of the marina slips 65 miles either side of Lock 10 are aggregated, the total is 3,209. Lock 10 also ranks second in recreation lockages. Table 3 also shows that the stretch of the river from Lock 17 through 25 tends to have the smallest number of recreation lockages on the Upper Mississippi River; likewise, this area also has fewer marina slips compared to the upper reach of the river. The one major exception is Lock 26. This pool alone has the largest number of marina slips, 2,156, and the smallest number of recreation lockages. The reason for the low recreation lockage is explained later in the report.

TABLE 3

RELATIONSHIP--SLIPS AVAILABLE/LOCKAGE  
(GREAT Supply Inventory--1977)

<u>Pool</u> <u>UPLSAF</u>	<u>Marina Slips</u>	<u>Recreation Lockage</u> <u>(1977)</u>
1	0	1,883
2	0	1,622
3	497	2,570
4	1,562 <sup>a/</sup>	3,852
5	1,332	3,027
5A	12	2,495
6	80	3,478
7	547	2,931
8	46	3,544
9	909	2,594
10	216	2,599
11	785	4,397
12	222	2,658
13	1,077	2,354
14	201	2,178
15	627	3,101
16	318	2,818
17	465	1,310
18	90	1,270
19	96	1,418
20	301	667
21	98	705
22	250	980
24	116	776
25	101	895
26	143	1,128
	2,156	329

a/ A total of 902 slips are available on the Lower St. Croix River.

Undoubtedly there were other factors involved in lockage, such as the distance between locks, the type of resources available in the pools, etc. Nevertheless, the initial conclusion was that the number of boats moored in the general area of the locks are more than likely associated with recreation lockage.

(4) Mississippi River Recreation Survey (1977):

During the summer and fall of 1977, GREAT conducted an on-site survey of dredge-material island users. It was designed to determine the characteristics of use and to evaluate users' perception of various river resources. The work was conducted by the University of Wisconsin in Madison.

c. Other Studies Related to the Upper Mississippi River

(1) Lower St. Croix River Recreation Survey:

Another study being conducted during the summer and fall of 1977 is a survey of recreation users on the lower St. Croix River. Also conducted by the University of Wisconsin, this study is designed to examine recreation use characteristics and resource perceptions of users. The study promises to supplement MRI's study of recreation lockage for the upper end of the Mississippi River, particularly in the vicinity of Locks 2, 3, and 4.

(2) Lake Superior Recreation Boating Study:

Another study, conducted by Roy F. Weston, Inc., of Wilmette, Illinois, is on recreation boating needs at Lake Pepin (Pool 4). The study should furnish supplemental data for Pool 4 in terms of use characteristics, access and slippage needs for that pool. Some of the study findings are discussed in a later chapter of this report.

2. Factors Lockage Methodology Should Include: As a result of this literature review, a list of possible factors affecting lockage was presented to the St. Paul District (see Table 4). Of course, some of these factors, such as the number of boats on a pool, could have a more significant effect than other factors, such as ancillary recreation use (i.e., swimming, fishing, water skiing, etc.). And unfortunately neither time nor funds were available to collect data for all the factors in the list.

In order to develop a model which would essentially be operable during late 1977, MRI concentrated on utilizing data that were essentially available during the summer of 1977. These data are described in Subsection a, "Data Available, Summer 1977."

TABLE 4

LOCKAGE FACTORS

Demand

- Recreation Participation (Water-Oriented)
- Leisure Time Activity Patterns
- Access
- Population (Growth/Shifts)
- Boat Registration

Supply

- Upper Mississippi Water Resources (Facilities, Water and Island Resources, Distance Between Locks)
- Competing Water Resources

Constraints

- Recreation Use vs. Commercial Use
- Perceptions on Lockage
- Awareness of Lockage Programs
- Weather and Water Levels

a. Data Available, Summer 1977: Four Corps data sources provided valuable input into the analysis. The first data source was annual commercial and recreation lockage data from 1971 through 1977; these data were graphically presented in Figure 2. A second Corps data source is Recreation Resource Management System (RRMS) visitation data by pool for 1963 through 1977. The RRMS data provide a breakdown of attendance at Corps-managed recreation areas and recreation areas managed by other agencies. Also included is average attendance on a weekend day during a peak month and the percentage of visitors participating in various activities.

The third item consists of a detailed summary of recreation lockages for 1975 and 1976. In addition to a summary of recreation craft activity by month for each pool, a daily log of use for each lock reiterates type of craft, boats per lockage, number of passengers, direction, time of day, and delay time. The

information was particularly useful in preparing a sample design for the recreation lockage survey.

Also concerned with the delay time is the fourth major source of data--the Dedicated Pleasure Craft Lockage study. Data from this study pinpointed hourly peak recreation lockages before and after the initiation of the program (Locks 2 and 7 only). Besides supplying MRI with a definite idea of hourly use patterns, the origin/destination results of the surveys at Locks 2 and 7 reinforced MRI's beliefs that: (1) pools have different use patterns; and (2) the primary market area is very local.

Another major source of recreation data was provided by the GREAT. The work done by GREAT I focused on identifying current and future trends in recreation participation for a selected number of activities on navigation pools on the Upper Mississippi River. The GREAT Recreation Demand Analysis addressed the problem of recreation demand on the pools within the jurisdiction of the St. Paul District.

A second data source from the GREAT was a recreation facilities inventory for all 28 pools in the Upper Mississippi River. Included in the inventory were land acres, marina facilities, access facilities and recreation facilities by pool. This information was partially used to assign a quality rating to the facilities and resources in the 28 pools.

Since the study area included portions of Minnesota, Wisconsin, Iowa, Illinois, and Missouri, several agencies in each of these states were contacted to secure state data. County population estimates and projections were available for the 5-year intervals, 1970, 1975, 1980, 1985, 1990, 1995, and 2000. (An exception to this was Missouri, which has projections for 1980 and 1990 only.) Recreation participation rates were applied to regional population projections to forecast the associated river-related activity for boating, fishing, swimming, water skiing, and canoeing.

Per capita participation rates from the most recent State Comprehensive Outdoor Recreation Plans were also obtained for the five states in the study area. Participation rates for Minnesota were taken from the 1968 plan; for Wisconsin from the 1972 plan; for Missouri from the 1970 and 1973 demand analysis update; for Iowa from the 1968 and 1975 demand update; and for Illinois from the 1970 and 1976 demand update. The only difficulty we encountered was that the State of Wisconsin statistics were in terms of recreation occasions per average weekend day compared to annual or seasonal per

capita participation rates for the other states. Also, there were no statewide trend data available for Wisconsin and Minnesota.

Another crucial data element was boat registrations by county. Historical data allowed MRI to establish trends in boating growth. The data from Minnesota, Wisconsin, and Illinois were available for 6 years. Iowa data, for 1976 only, were available at the end of June. Missouri data were available for 1973 to 1976, but year-to-year comparisons were not always possible due to inefficient retirement of old records. Numerous cases of double counting were noted until the files were purged a year or two ago, which resulted in a definite drop in numbers of boat registrations. These data were supplemented by the annual "Boating Statistics," published by the U.S. Coast Guard.

b. Data Gaps: Even with the available data, there were several significant gaps that had to be overcome to develop a methodology and forecasts of recreation use and lockages on the Upper Mississippi River. These data gaps included: the amount of recreation participation for individual water-related activities occurring on the Upper Mississippi river; the distance boaters travel by land and water to lock through Corps facilities, the various perceived constraints people have about using Corps lockage facilities, and the current amount of river running. In light of these data gaps, two surveys were proposed in the Phase I presentation to acquire data necessary to complete the study.

- Lockage User Survey - On-site at a selected number of locks.
- Demand Origination Survey - A random telephone survey in selected areas in the primary zone of influence.

Because of the high cost necessary to obtain a statistically reliable sample, the St. Paul District, together with the reviewing team, decided that the demand origination survey should be delayed at this time. Unfortunately, this hampered the analysis of recreation use as will be subsequently shown. There was, however, general agreement that the on-site lockage survey could provide considerable data for development of the methodology and forecasts. In addition, several general use questions were included in the surveys to be conducted by Roy F. Weston, Inc., and the University of Wisconsin, and these data are expected to supply supplementary input to the recreation use analysis.

c. Recreation Lockage Survey: As was pointed out in the previous section, there were major data gaps in characterizing recreation lockage. For example, although total annual recreation lockages were available in terms of number of boats passing through the locks, as well as recreation lockages by hour, day of week, and month, no data were available describing the distances recreation boaters travel or other important use characteristics. Thus, it was not possible to determine whether recreation lockages are the result of a local phenomenon; that is, a pool is crowded and recreation boaters lock through to get to less crowded areas; or recreation lockages are part of a river running experience; that is, longer trips with several lockages along the way. To shed some light on these and other important aspects of recreation boating on the Upper Mississippi, a survey was undertaken during the summer of 1977. The following types of information were obtained:

- Type of recreation craft;
- Residential origin;
- Point at which the boating experience started and culminated;
- Frequency of lockage use;
- Recreation activities pursued on the trip;
- Annual usage patterns; and
- Perceived problems, constraints, etc.

Two crews of two students each conducted the survey at 18 different locks during a 6-week period starting on the July 4 weekend. In order to gain the maximum possible contact with recreation lockage users, interviews were conducted from Friday through Tuesday each week. The survey crews worked 8 hours per day during this period, and actual time at the lock was staggered so that a sample of early morning as well as late evening users could be interviewed.

Recreation boaters using the locks were interviewed as they passed through the lock. As the boaters positioned themselves against the lock walls using the lines dropped to them by Corps personnel, they were asked about their trip. (A copy of the interview instrument is located in Appendix A.) The survey crews

were instructed to interview every recreation boater using the locks during their period of duty. It was recognized, however, that during peak weekend days a few boats might pass through the locks before the survey crews would be able to interview them. In this case, the crews were instructed to systematically sample the total multiple lockage (i.e., every other boat in the lock, etc.).

(1) The Sample: A total of 1,464 usable questionnaires was obtained as a result of the lockage survey. Most of these were recorded between 12:00 noon and 5:00 p.m. (70.4 percent). Table 5 shows the distribution of these questionnaires by lock.

TABLE 5

DISTRIBUTION OF QUESTIONNAIRES BY LOCK

<u>Lock</u>	<u>Frequency (Number)</u>	<u>Frequency (Percent)</u>
1	32	2.2
2	188	12.8
3	144	9.8
5	92	6.3
7	173	11.8
10	197	13.5
11	203	13.9
12	71	4.8
13	79	5.4
15	99	6.8
16	50	3.4
17	21	1.4
19	17	1.2
20	4	0.3
21	23	1.6
22	15	1.0
25	38	2.6
USAF	18	1.2
Total	1,464	100.0

(2) The Analysis: The survey crews mailed the completed questionnaires to MRI at least twice each week. The questionnaires were immediately coded, keypunched, and verified. At the conclusion of the final week, therefore, the questionnaires

were almost immediately available for analysis. The Statistical Program for Social Sciences (SPSS) was utilized to analyze the lockage data. Prior to the analysis, however, a computer edit was made of the data to assure consistency in answers. After a trial run with the SPSS, there appeared to be a difference between lockage patterns on the upper and lower stretches of the river. Therefore, the data were divided into a northern and southern region. Although selected tables and averages were prepared for these regions, cross-tabulations were prepared only for the river as a whole. The survey results are described in the next chapter.

## CHAPTER IV

### RECREATION LOCKAGE USER CHARACTERISTICS

(Summer 1977)

Available PMS (Performance Monitoring System) data for lockage users on the Mississippi River revealed only the number of boats passing through the locks, the number of recreation lockages, the time of day, and the number of persons per boat. Information was not available on the type of craft, the distances people travel, or other statistics that are pertinent to developing a methodology to forecast future lockage. Therefore, it was proposed that a survey of lockage users be conducted as a part of the Phase II research. This survey began on the July 4 weekend, and was continuous through approximately August 15. During that period, a total of 1,464 usable questionnaires was obtained.

It is emphasized that the characteristics described below apply only to the summer of 1977. The usage during the spring and fall may differ significantly. And if the Corps of Engineers desires to refine the lockage forecasting methodology that is described in this report, a priority item that should be considered is a continuous survey of selected questions covering all seasons. Periodically, perhaps every 5 years, the entire survey should be updated to learn about trends in overall use characteristics (see Chapter VII for recommendations).

The survey results are described in the following sections. First, an overall analysis of the river and the two regions is provided. Summary tables, averages, and ranges are presented; the last section includes a discussion of cross-tabulations for important variables. Included in that section is an analysis of statistically significant relationships (see Appendix B).

#### A. The Upper Mississippi River (Upper St. Anthony Falls Through Lock 26)

Slightly over two-fifths (43 percent) of all recreation craft using the locks on the Upper Mississippi River are runabout class; about one-third (38 percent) are some type of cruiser, with nearly 16 percent houseboat class (see Table 6). Few fishing boats (less than 3 percent) are presently using the locks on the Upper Mississippi River.

TABLE 6

TYPE OF BOATING CRAFT USING THE LOCKS ON  
THE UPPER MISSISSIPPI RIVER

<u>Type of Craft</u>	<u>Frequency</u>	<u>Percent</u>	<u>Average One-Way River Mileage</u>
Runabout	630	43.1	122
Cruiser	475	32.5	163
Large Cruiser	79	5.4	177
Sailing Cruiser	2	0.1	- <u>a/</u>
Houseboat	228	15.6	127
Fishing Boat	41	2.8	52
Other	8	0.5	- <u>a/</u>
	<u>1</u>	<u>Missing</u>	
<b>Total</b>	<b>1,464</b>	<b>100.0</b>	

a/ Insufficient data to establish averages.

The direction of travel is split nearly evenly with 46 percent of the craft traveling upstream, and 54 percent going downstream. During the average trip, boats contain four people (3.91) and use 9.42 locks. Most of these trips (96.5 percent) are round trip with an average one-way river mileage of 126 miles.

As might be expected there is a relationship between the type of craft and the average distance traveled on the river. For example, runabouts are traveling an average distance of 122 miles; cruisers, large cruisers, and houseboats are on longer trips, averaging 163 miles, 177 miles, and 127 miles, respectively. Fishing boats travel the shortest distance, averaging 52 miles.

A total of 51.2 percent of all recreation boats using the locks are moored at a marina; 43.2 percent of the users transport their boat to the point of launching by trailer. The remaining 5.6 percent are rental or borrowed boats.

Nearly half of the lockage users indicate that they live either in the town of their home marina or launching point, or within 10 miles. Seventy percent are located within 50 miles, 83 percent within 100 miles (see Table 7).

TABLE 7

DISTANCE FROM RIVER DEPARTURE POINT TO RESIDENCE

<u>Distance Category</u>	<u>Frequency</u>	<u>Percent</u>
0 to 10	721	49.2
11 to 15	157	10.7
26 to 50	152	10.4
51 or more	<u>434</u>	<u>29.6</u>
Total	1,464	100.0

Most recreation users (52.4 percent) indicate they are on a trip of 3 days or more. Less than one-third (29.2) percent) are on a day outing (see Table 8). One-third of the lockage users indicate they are traveling in a group with other boats. The average group is composed of 3.2 boats. Nearly half of the lockage users say they make a similar type of trip at least 1 to 5 times per summer; 44 percent go on a similar trip 6 to 20 times; and 8 percent, 21 or more times per summer.

TABLE 8

DURATION OF THE BOATING TRIP

<u>Duration</u>	<u>Frequency</u>	<u>Percent</u>
One Day	427	29.2
Two Days	267	18.3
Three or More	767	52.5
	<u>3</u>	<u>Missing</u>
Total	1,464	100.0

The most popular recreation activity participated in by recreation lockage users is swimming (70.4 percent of the groups). Picnicking and camping are also popular activities (67.9 and 65.9 percent). A total of 38.2 percent of the groups camp on the dredge spoil islands while 16.6 percent camp on their boats. Most indicated that camping (sleeping) on their boat takes place at commercial

marinas along the river. Thirty-six percent of the lockage users water ski, and about one-fourth (25.3 percent) of the lockage users fish during their outdoor recreation experience (see Table 9).

TABLE 9

RECREATION ACTIVITIES PARTICIPATED IN DURING THE BOATING TRIP

<u>Activity</u>	<u>Percent of the Groups</u>
Fishing	25.3
Swimming	70.4
Water Skiing	36.1
Picnicking	67.9
Camping	
On Spoil Islands	38.2
Boat	16.6
Other Areas	11.1

The recreation lockage users were asked to comment on the locks or lock usage. To prevent bias in the answer, the question was left open-ended to allow users to comment on those items that were most important in their minds. Although most provided comments, many said nothing in response to this question. A total of 69.5 percent commented on the service provided at the locks; 65.8 percent considered the service either excellent, good or satisfactory. Only 3.7 percent of the users said the service provided by the Corps of Engineers was either poor or bad. Fourteen percent of the recreation lockage users made comments about excessive delays or complained about barges. A total of 7.7 percent indicated a need for auxiliary locks to alleviate conflicts with commercial craft. A number of users made comments about the need for information, technical problems, or other problems as they perceived them (see Table 10).

TABLE 10

BOATERS COMMENTS CONCERNING LOCKS OR LOCK USE

<u>Type of Comment</u>	<u>Frequency</u>	<u>Percent</u> <sup>a/</sup>
Excellent Service	128	8.7
Good Service	531	36.3
Satisfactory Service	304	20.8
Poor Service	18	1.2
Bad Service	36	2.5
Excessive Delay	75	5.1
Barge Complaints	130	8.9
Information Needed	18	1.2
Technical Problems	71	4.8
No Fee Please	41	2.8
Locks Dirty and Slimy	13	0.9
Improved from Past	24	1.6
First Time User	30	2.0
Prefer Dedicated	33	2.3
Need Aux Locks	112	7.7
Misc. Comments	11	0.8

<sup>a/</sup> Potential respondents (1,464).

B. Regional Characteristics

After discussions with the St. Paul staff and MRI field visits during the survey, it was felt that the southern and the northern sections of the river differ both in character and use characteristics. Prior to ordering the final SPSS run, summary tables and averages were examined at each of the locks. Because of the size of the sample, it was not possible to provide individual statistics by lock. The sample appeared to be of sufficient size to examine regional differences, however. Using the number in the sample as a basic guide, and then examining individual lock differences at a point on the river which would divide the sample approximately in half, two regions were established. The northern section includes a section of the river beginning with the Upper St. Anthony Falls, ranging down through Lock 10. The southern section of the river

includes Locks 11 through 26. The regional differences are described in the following sections.

In general, it appears that recreation lockage users in the southern section of the river are traveling longer distances and using more locks traveling north to various recreation areas. They also are more likely to be traveling in large cruisers and houseboats. In addition, they are more heavily involved in outdoor recreation activities, especially camping.

1. The Northern Section: There is an average of 3.9 persons per boat using the northern locks. The average number of locks used in the entire trip for boats in the northern region is 9.1; the average river miles traveled during the trip is 113 miles round trip. Over two-thirds of the trips involve 100 miles or less on the river (see Table 11).

Nearly half of the boats using the northern locks (46.9 percent) are runabout class; 35.3 percent are cruisers and 14.1 percent are houseboats (see Table 12); 49.4 percent of these boats are moored at commercial marinas on the river.

As was the case with the river as a whole, there was a relationship between the type of craft and the average distance traveled by boats in the northern section. Runabouts average 82 miles per trip; cruisers, large cruisers and houseboats are on much longer trips, averaging 160 miles, 150 miles, and 113 miles, respectively. Again, fishing boats travel the shortest distance on the river, averaging 57 miles per trip.

Almost half of the lockage users (49 percent) are on a trip of 3 days or more; 31.3 percent are on a day outing (see Table 13). A total of 37 percent of the boats using the northern locks are traveling in groups of two or more boats, with an average group containing 3.5 boats. The most popular activities are swimming and picnicking, with 66 percent of the groups participating in each activity. A total of 58 percent are camping, with 29 percent camping on the dredge spoil islands. About one-fourth of the groups participate in fishing (see Table 14).

Forty-four percent of the users of the northern locks indicate they live in the town of their home marina or launching point, or they live within 10 miles; a total of 70 percent live within 50 miles of their home marina (see Table 15).

TABLE 11

TOTAL MILES TRAVELED ON THE RIVER(S)

<u>Distance Category</u>	<u>Upper Mississippi River</u>		<u>Northern Section<sup>a/</sup></u>		<u>Southern Section<sup>b/</sup></u>	
	<u>Percent</u>	<u>Cumulative Percent</u>	<u>Percent</u>	<u>Cumulative Percent</u>	<u>Percent</u>	<u>Cumulative Percent</u>
0 to 50	44.9	44.9	44.3	44.3	45.6	45.6
51 to 100	20.4	65.3	23.5	67.8	16.3	61.9
100 to 150	8.5	73.8	9.7	77.5	6.8	68.7
151 to 200	5.3	79.1	5.0	82.5	5.8	74.5
201 or more	<u>20.9</u>	<u>100.0</u>	<u>17.5</u>	<u>100.0</u>	<u>25.5</u>	<u>100.0</u>
	100.0		100.0		100.0	

a/ Upper St. Anthony Falls through Lock 10.

b/ Lock 11 through Lock 26.

TABLE 12

TYPE OF BOATING CRAFT USING THE LOCKS  
(Northern Section of the Upper Mississippi River)

<u>Type of Craft</u>	<u>Frequency</u>	<u>Percent</u>	<u>Average One- Way River Mileage</u>
Runabout	396	46.9	82
Cruiser	264	31.3	160
Large Cruiser	33	3.9	150
Sailing Cruiser	1	0.1	- a/
Houseboat	119	14.1	113
Fishing Boat	28	3.3	57
Other	<u>3</u>	<u>0.4</u>	- a/
Total	844	100.0	

a/ Insufficient data to establish averages.

TABLE 13

DURATION OF BOATING TRIP  
(Northern Section of the Upper Mississippi River)

<u>Duration</u>	<u>Frequency</u>	<u>Percent</u>
One Day	264	31.3
Two Days	166	19.7
Three or More	413	49.0
	<u>1</u>	<u>Missing</u>
Total	844	100.0

TABLE 14

RECREATION ACTIVITIES PURSUED DURING THE BOATING TRIP  
(Northern Section of the Upper Mississippi River)

<u>Activity</u>	<u>Percent of the Groups</u>
Fishing	24.8
Swimming	66.0
Water Skiing	32.3
Picnicking	65.9
Camping	
On Spoil Islands	29.0
Boats	20.0
Other Areas	9.0

TABLE 15

DISTANCE FROM RIVER DEPARTURE POINT TO RESIDENCE  
(Northern Section of the Upper Mississippi River)

<u>Distance Category</u>	<u>Frequency</u>	<u>Percent</u>	<u>Cumulative Percent</u>
0 to 10	371	44.0	44.0
11 to 15	108	12.8	56.8
26 to 50	108	12.8	69.6
<u>51 or more</u>	<u>257</u>	<u>30.5</u>	<u>30.5</u>
Total	844	100.0	100.0

A total of 62.3 percent of northern lockage users say the lockage service by the Corps of Engineers ranges from excellent to satisfactory. Most of these users (39 percent) indicate the service is good. A total of 2.8 percent say service is either poor or bad. Excessive delays and barge complaints are mentioned by 12.8 percent of the lockage users, and at least 6 percent indicate the need for auxiliary locks. The remainder of the comments are mentioned by 4 percent or less of the lockage users (see Table 16).

TABLE 16

BOATER COMMENTS CONCERNING LOCKS OR LOCK USE  
(Northern Section of the Upper Mississippi River)

<u>Type of Comment</u>	<u>Frequency</u>	<u>Percent<sup>a/</sup></u>
Excellent Service	73	8.6
Good Service	329	39.0
Satisfactory Service	124	14.7
Poor Service	11	1.3
Bad Service	13	1.5
Excessive Delay	42	5.0
Barge Complaints	66	7.8
Information Needed	12	1.4
Technical Problems	35	4.1
No Fee Please	10	1.2
Locks Dirty and Slimy	10	1.2
Improved from Past	13	1.5
First Time User	17	2.0
Prefer Dedicated	24	2.8
Need Aux Locks	51	6.0
Misc. Comments	10	1.2

<sup>a/</sup> Potential respondents (844).

2. The Southern Section: A total of 620 usable questionnaires was available for analysis on the lower section of the Upper Mississippi River. The average boat using the southern locks contains 3.9 persons. Although the average boating trip involves lockage at 9.9 Corps of Engineers locks, the overall distribution of lockage is similar to the northern section (see Table 17). The total

TABLE 17

TOTAL LOCKS USED ON THE UPPER MISSISSIPPI RIVER (ROUND TRIP)

<u>Number of Locks</u>	<u>Upper Mississippi River</u>		<u>Northern Section<sup>a/</sup></u>		<u>Southern Section<sup>b/</sup></u>	
	<u>Percent</u>	<u>Cumulative Percent</u>	<u>Percent</u>	<u>Cumulative Percent</u>	<u>Percent</u>	<u>Cumulative Percent</u>
0 to 5	54.6	54.6	52.5	52.5	54.7	54.7
6 to 10	16.0	70.6	19.0	71.4	16.9	71.6
11 to 15	6.7	77.3	9.6	81.0	6.5	78.1
16 or more	22.7	100.0	19.0	100.0	21.9	100.0
	100.0		100.0		100.0	

a/ Upper St. Anthony Falls through Lock 10.

b/ Lock 11 through Lock 26.

distance traveled on the river in the southern section also tends to be somewhat longer than trips on the northern section, 144 miles compared to 113 miles.

The mix of boats using the locks on the southern portion of the Upper Mississippi tends to be more cruisers and fewer runabouts. There are 37.7 percent of runabout class and 41.6 percent in the cruiser class. There are also slightly more houseboats than in the northern section with a total of 17.6 percent (see Table 18). Fifty-nine percent of these boats are moored at a commercial marina.

TABLE 18

TYPE OF BOATING CRAFT USING THE LOCKS  
(Southern Section of the Upper Mississippi River)

<u>Type of Craft</u>	<u>Frequency</u>	<u>Percent</u>	<u>Average One Way River Mileage</u>
Runabout	234	37.8	109
Cruiser	211	34.1	168
Large Cruiser	46	7.4	197
Sail Cruiser	1	0.2	<u>a/</u>
Houseboat	109	17.6	143
Fishing Boat	13	2.1	42
Other	5	0.8	<u>a/</u>
	<u>1</u>	<u>Missing</u>	
Total	620	100.0	

a/ Insufficient data to establish averages.

Again, there was a difference between the type of boat and the average distance traveled on the river for boats in the southern section. Runabouts are on an average trip of 109 miles. As was the case with the Upper Mississippi River and the northern section, cruisers, large cruisers, and houseboats tend to be on much longer trips averaging 168, 197, and 143 miles. Fishing boats in the southern section averaged 42 miles per trip.

More of the users of the southern locks indicate they live in the town of their home marina or launching point. A total of 57 percent indicate they reside within 10 miles of the point of departure on the river, compared to 44 percent of the northern lock users. Fewer boaters in the southern section live in the middle ranges (11 to 50 miles), and about the same number live 51 miles or more from that point (see Table 19).

TABLE 19

DISTANCE FROM RIVER DEPARTURE POINT TO RESIDENCE  
(Southern Section of the Upper Mississippi River)

<u>Distance Category</u>	<u>Frequency</u>	<u>Percent</u>	<u>Cumulative Percent</u>
0 to 10	350	56.5	56.5
11 to 15	49	7.9	64.4
26 to 50	44	7.1	71.5
51 or more	<u>177</u>	<u>28.5</u>	100.0
Total	620	100.0	

A greater portion of the lockage users on the southern section of the river indicated their trips would last 3 days or more (57.3 percent compared to 49 percent in the northern section) (see Table 20). Likewise, fewer were on day outings (26.4 percent compared to 31.3 percent). A total of 32 percent of these lockage users were traveling in groups composed of two or more boats, with the average group of 2.9 boats.

TABLE 20

DURATION OF BOATING TRIP  
(Southern Section of the Upper Mississippi River)

<u>Duration</u>	<u>Frequency</u>	<u>Percent</u>
One day	163	26.4
Two days	101	16.3
Three or more	354	57.3
	<u>2</u>	<u>Missing</u>
Total	620	100.0
	39	

Swimming, picnicking, and camping are all popular activities among lockage users on the southern section of the river (see Table 21). A total of 76.3 percent, 70.6 percent and 76.4 percent participated in each of these activities, respectively. Camping on dredge spoil islands was especially popular among users of the southern locks, with 51 percent expecting to use the dredge spoil during their trip. A total of 41.1 percent of the groups intended to water ski and about one-fourth, 26.0 percent, expected to fish during their trip.

Over 70 percent of the users of the southern locks indicated that service at the locks ranged from satisfactory to excellent with 32.6 percent indicating the service was good. About 5 percent of the lockage users said service at the locks was either poor or bad. There were slightly more comments regarding excessive delay and barge complaints on the southern section of the river (15.6 percent). Also, a larger number (9.8 percent) indicated a need for auxiliary locks. Other comments are shown in Table 22.

### C. Discussion of Survey Results

As a part of the analysis, various cross-tabulations of interview questions were examined in an attempt to isolate important lockage relationships.<sup>1/</sup> The cross-tabulations are discussed in terms of the type of craft, the period of use, and general trip characteristics. Statistically significant relationships mentioned are to the 0.01 level of significance.

1. Type of Craft: As might be expected, runabouts generally contain four people or less. Only 22.7 percent had more than four, with only 1.4 percent containing more than nine persons. A larger percentage of cruisers contained more than four passengers; a total of 43.4 percent of the houseboats had more than four passengers, with 9.2 percent having more than nine passengers.

There was a significant relationship between type of craft and whether or not the craft was moored. Almost three-fourths of the runabouts were not moored at a commercial marina, whereas a large portion of the cruisers and houseboats were (67 percent of the cruisers, 89 percent of the large cruisers, and 93 percent of the houseboats).

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<sup>1/</sup> Selected statistically significant Chi-square contingency tables are contained in Appendix B.

TABLE 21

RECREATION ACTIVITIES PURSUED DURING THE BOATING TRIP  
(Southern Section of the Upper Mississippi River)

<u>Activity</u>	<u>Percent of Groups</u>
Fishing	26.0
Swimming	76.3
Water Skiing	41.1
Picnicking	70.6
Camping	
On Spoil Islands	50.6
Boats	11.9
Other Areas	13.9

TABLE 22

BOATERS COMMENTS CONCERNING LOCKS OR LOCK USE  
(Southern Section of the Upper Mississippi River)

<u>Type of Comment</u>	<u>Frequency</u>	<u>Percent<sup>a/</sup></u>
Excellent Service	55	8.9
Good Service	202	32.6
Satisfactory Service	180	29.0
Poor Service	7	1.1
Bad Service	23	3.7
Excessive Delay	33	5.3
Barge Complaints	64	10.3
Information Needed	6	1.0
Technical Problems	36	5.8
No Fee Please	31	5.0
Locks Dirty and Slimy	3	0.5
Improved from Past	11	1.8
First Time User	13	2.1
Prefer Dedicated	9	1.5
Need Auxiliary Locks	61	9.8
Miscellaneous Comments	1	0.2

a/ Potential respondents (620).

This is obviously a result of larger boats being less mobile and thus having to be moored at a permanent installation.

Users of runabouts were generally on shorter trips than were users of larger craft. Three-fourths of the lockage users in runabouts were on trips that would cover 100 miles or less on the river. Forty-six percent of the lockage users in cruisers and 36 percent of those in houseboats said their trip would cover over 100 miles on the Mississippi.

The relationship between type of craft and duration of trip is significant. No doubt because of the longer distances covered on the rivers, a larger percentage of users in cruisers and houseboats indicated their trip would last more than 3 days. Sixty-five percent of the cruiser users, 79 percent of the large cruiser users, and 74 percent of houseboats users said their trip would last 3 days or more, whereas 46 percent of the runabout owners and 68 percent of the fishing boat users said they were on a day outing.

Probably because of the longer trips, the larger craft tended to be using more locks per trip than did runabout and fishing boat users. A total of 81 percent of the runabout operators used 10 locks or less; over 90 percent of fishing boat operators used less than 10 locks on a given trip. Forty-one percent of the cruisers, 49 percent of the large cruisers, and 27 percent of the houseboats utilized 11 or more locks on each trip.

Although slightly less defined, there appears to be a relationship between the type of craft and the number of similar types of trips owners tend to take each summer. Over half of the runabout respondents (53.8 percent) indicated they would take a similar type of trip between 1 and 5 times during a summer. Fewer large craft owners (cruisers, large cruisers, and houseboats) indicated they would take between 1 and 5 trips annually, but most of the larger boat owners indicated they would take more trips in the 6 to 20 category than the runabout owners (over half of the large cruiser owners, and almost half of cruiser and houseboat owners). Between 7 and 10 percent of the runabout, cruiser, large cruiser, and houseboat owners indicated they would take 21 or more similar types of trips annually. Fishing boat owners on the other hand were almost evenly distributed in the three trip categories. Nearly 28 percent indicated they would take 21 or more trips similar to the one they were on.

These data imply that because of the limited overnight accommodations aboard runabouts, travel in this type of craft will

be confined to more local areas. As a result, runabouts will probably exert the greatest pressure on Corps locks during mid-afternoon on weekends.

2. Period of Use: Consistent with the above findings, the use of locks by runabouts during the weekend peaks almost 10 percent above use during weekdays. The percentage of total use by cruisers, houseboats, and fishing boats is much more balanced throughout the week and does not show weekend peaking.

Probably because of peaking characteristics exerted by runabouts on local trips, over half of the lockage users on weekend trips will cover a total river mileage of less than 50 miles. The relationship between the period of use (weekday or weekend) and river mileage is significant with approximately the same percentage of boats traveling less than and more than 100 miles during weekend days.<sup>1/</sup> On the weekend, however, three-fourths of the crafts are on trips of less than 100 miles with only 15 percent on trips of more than 200 miles.

The relationship between time of lockage and total river miles traveled by boating craft is also significant.<sup>1/</sup> Between 45 and 50 percent of the craft passing through the locks between noon and 8:00 p.m. are on trips of less than 50 miles. Thirty-eight percent of the craft passing through the locks between 8:00 a.m. and noon are on trips of more than 100 miles. This compares to 33 percent of the craft traveling this distance during the period from noon to 6:00 p.m. It can also be noted that in the evening long-distance traffic again begins to pick up with 45.5 percent of the craft using the locks during this period traveling more than 100 miles on the river.

The relationship of the duration of trip and whether or not the lockage occurs on a weekday or weekend is significant.<sup>1/</sup> Almost three-fourths of the recreation lockages occurring on the weekday are of a total duration of 3 or more days. Weekend trip duration is more evenly distributed with 36 percent being 1 day, 23 percent 2 days, and 41 percent 3 days. This is probably the result of a large portion of the trips being 1-day outings on the weekend and a larger portion of weekday travel being vacation usage.

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<sup>1/</sup> Significant relationships mentioned in the discussion are contained in Appendix B.

There is a significant relationship between the duration of the trip and the time period that the recreation lockage occurs. Early lockage (8:00 a.m. to noon) tends to be boaters on longer trips (57.3 percent). During the mid-day period (noon to 6:00 p.m.) a large percentage (31.6 percent) of the recreation lockages are on 1-day trips. The evening period again is dominated by lockage users who are on trips of 3 days or more. Day users appear to depart during the mid-day period and return home before 6:00 p.m., whereas those on longer trips tend to stay on the river early and late.

The relationship between weekday and weekend lockage and the total number of locks utilized on a single trip is also significant. Probably because of peaking of 1-day outings on the weekend, a large portion (62 percent) of the lockage users indicate they will use five or less locks on a trip. This compares to only 38.1 percent on a weekday period. At the other end of the spectrum, on weekdays 45 percent of the users say they will use 11 or more locks on a trip compared to 20 percent of weekend users. The conclusion regarding the period of use seems obvious--that peak use periods exist. Weekend trips are shorter, use less locks, and generally take place within a relatively short period of time between 10:00 a.m. and 6:00 p.m. Weekday recreation lockage is spread over the entire day, involves craft on long trips utilizing many locks, and may last a week or more.

3. Trip Characteristics: Another set of relationships of specific interest to Corps of Engineers' operations and planning personnel is the general trip characteristics exhibited by lockage users. These characteristics assist in understanding type of lockage use presently occurring and may give a clue to what may happen in the future.

The analysis basically cross-tabulates boats moored and transported by a trailer with other trip characteristics. It should be remembered that boats moored tend to be the larger craft, on trips of longer duration, traveling longer distances and using more locks.

There is a significant relationship between the road miles traveled to the point of departure on the river and whether or not the boat was moored. Almost three-fourths of the lockage users indicating their boat was moored at a commercial marina said they travel 15 miles or less to get to the marina. This compares to 44 percent of nonmoored lockage users. The interpretation seems apparent. Those transporting their boat by trailer have the option of using a variety of resources, and thus tend to travel further to get to the Mississippi River and other resources. Those who repeatedly use the

Mississippi River via a boat moored at a marina reside close to the boat so they can use it often.

There is also a significant relationship between boats moored at the entry point and total river miles traveled. The larger boats moored at the point of departure tend to be the craft utilizing locks on longer trips (100 miles or more). The nonmoored craft tend to be on shorter trips (less than 100 miles).

Consistent with the previous relationship, the duration of the trip cross-tabulated with whether or not a boat is moored also shows a significant relationship. Almost two-thirds of the lockage users indicating their boat was moored at point of entry were on a trip that would last 3 days or more. This compares to only 42 percent of nonmoored boats. At the other extreme, nearly 40 percent of the nonmoored boats are on a 1-day trip. This compares to one-fifth of the moored boats on 1-day trips.

Because of the longer trips, moored boats also tend to be those utilizing more locks on a trip. Thus, total locks used on a trip compared to whether or not boats are moored also shows a significant relationship. A total of 26 percent of the lockage users utilizing 16 or more locks indicated their boat was moored at the point of entry. This compares to 15 percent for the nonmoored boats.

Probably because boats are moored nearby, lockage users indicate more frequent use of their craft. Thus, the number of similar trips during the summer compared to whether or not boats are moored also shows a significant relationship. Thirty-eight percent of the lockage users indicating their craft are moored at the point of river entry say they will go on a similar type of trip from 1 to 5 times during the summer; this compares with almost 60 percent of the nonmoored lockage users. However, 12 percent of the moored lockage users said they would go on at least 21 or more trips during the summer. Only 5 percent of the nonmoored lockage users indicated this frequency of use.

There is a significant relationship between moored craft and lockage users traveling in groups. Thirty-one percent of the lockage users with a craft moored at point of entry indicate they are traveling in a group. This compares to 38 percent of the nonmoored lockage users. Because the bigger boats travel greater distances for a longer duration, they probably tend to carry single families on vacations whereas the smaller boats out for the weekend are more likely to carry groups of friends, with similar types of boats traveling to a picnic area or other recreation facility on

the river. This is supported by the fact that a larger percentage of the nonmoored lockage users indicate that they are traveling in larger groups than the moored craft; this relationship is significant. Sixty-six percent of the lockage users with moored craft who are traveling in groups are in groups of two. This compares to 52 percent of the nonmoored lockage users indicating they are traveling in the same size groups. Forty-eight percent of the nonmoored lockage users traveling in groups are in groups larger than two; this compares to 34 percent of the lockage users with moored craft.

Oddly enough, the lockage users traveling in groups tend to be on trips of longer than 1 day. The relationship between duration of trip and whether or not the lockage user was traveling with a group was significant. Only 16 percent of those traveling in groups were on a 1-day outing. This compares to 44 percent on 2-day trips, and 42 percent traveling 3 or more days. Group travel probably occurs on two types of trips. One is the weekend overnight trip, taking place with a group of friends; the second is the longer distance vacation trip, taken by groups of families.

4. Implications for the Future: The above data seem to imply that lockage near major metropolitan areas will continue to experience extreme peaking during weekends and holidays. Not only are a large number of boats moored near a few locks, but weekend boating enthusiasts with small runabout craft will not stray far from their home berth. Recreation lockage along more rural sections of the Mississippi River will probably continue to be more balanced, i.e., recreation lockage occurring during all times of the day and week because of long distance traffic from major metropolitan areas en route to recreation destinations.

## CHAPTER V

### METHODOLOGY AND FORECAST OF SMALL CRAFT LOCKAGES

This chapter describes the methodology and provides forecasts of small craft lockages for 1980, 1985, 1990, 1995, and 2000. First, the hypotheses tested in developing the model are described. Then the factors tested in the model are listed and the methodology for developing the derived variables (i.e., quality ratings, etc.) are described. Finally, the regression analysis used to establish a relationship between various factors and small craft lockage is described, with the final model for forecasting small craft lockages outlined. This model provides a basic framework around which the St. Paul District may modify and expand as data become available. Finally, the forecasts produced by the methodology are summarized and the 1980 forecasts are compared to the 1976 lockage figures.

#### A. Research Hypotheses

After a 6-year trend in lockage at each lock on the Upper Mississippi had been examined graphically, scatter diagrams were manually prepared utilizing a one-on-one relationship between various assumed important factors and recreation lockage. In these scatter diagrams, the Y axis was recreation boats through the locks at all 28 locks. The X axis was independent variables that were hypothesized to have a major influence on recreation boats through the locks. Three variables were hypothesized to have a major impact on small craft lockages:

- A surrogate describing boating activity above and below the locks. In other words, a lock located close to areas of high boating activity would be expected to have more boats passing through the lock than one located in a rural area where low boating activity occurs.
- A factor describing the level of long distance traffic flow through a lock. In this case, some rural locks may experience a moderate level of recreation lockage as a result of boats traveling long distances on their way to destination areas. It would be expected that the bulk of the traffic at these types of locks may be boats making multiple lockages.

This occurrence is contrasted with a lock located near a metropolitan area, where the bulk of lockage may be only one pool up or down from the facility.

- Amount of commercial traffic. A lock where commercial traffic is high (e.g. Lock 26) would be expected to have less recreation traffic than one where commercial traffic is low.
- Distance to the next lock. A lock that is 40 to 50 miles in length would normally be expected to have less traffic from another pool than one located only 5 to 10 miles from the next lock.

Other factors that were hypothesized to influence small craft lockage included a quality ranking of pools measuring resource potential, and possibly an interaction among the variables described above.

#### B. Variables Tested in the Model

The scatter diagrams showed a weak relationship with regard to several variables, indicating more than one variable was probably involved in small craft lockage. Thus, it was decided that multiple regression techniques would be an appropriate tool to develop a forecast methodology. Using the SPSS program and input data obtained from various sources and the lockage survey, an attempt was made to predict the number of recreation boats through a lock (Y) with the aid of 11 candidate predictors (X's). The independent variables, a description of which follows, were:

- $X_1$  = Commercial marina slips (above and below the lock);
- $X_2$  = Flow factors;
- $X_3$  = Commercial lockages;
- $X_4$  = Miles to next lock (above and below the lock);
- $X_5$  = Recreation quality of pools (above and below lock);
- $X_6$  = Commercial marina and private slips (upstream);

- $X_7$  = Commercial marina and private slips (downstream);
- $X_8$  = Miles to next lock (upstream);
- $X_9$  = Miles to next lock (downstream);
- $X_{10}$  = Recreation quality of pool (upstream);
- $X_{11}$  = Recreation quality of pool (downstream);

The sources and derivation for these variables are described below:

1. Commercial Marina Slips: It was hypothesized that boating activity above and below the locks would affect the number of recreation lockages. Several variables were examined as surrogates of boating activity. Among these were the GREAT aerial survey of July 4, 1976 and the Corps boating activity days from the RRMS. The former data were for only one point in time and did not show a strong relationship. The latter data did not appear to be valid. For example, several of the pools with the highest number of boating days estimated for 1976 had the lowest population concentrations along the river. In general, MRI has noted on previous occasions that RRMS data are often in error and thus not reliable for statistical analysis.

Marina slips generally are a good surrogate (indicator) of activity. The GREAT supply inventory was utilized as the data source for commercial marina slips in the regression analysis. Variable  $X_1$  included all slips above and below each lock. It should also be noted that all commercial marina slips on the St. Croix River were considered as a part of the slips above Lock and Dam 3. The data utilized in the regression analysis are located in Appendix C.

2. Flow Factors: The flow factors  $X_{2(I)}$  and  $X_{2(II)}$  were developed from the 1977 recreation lockage survey. Two sets of flow factors were tested. The factor was developed by simply normalizing the values for each lock or section of the river (i.e., the lock or section average of total locks used on a trip was divided by the mean for the entire river). Since several locks had well over 100 survey questionnaires, the flow factors were established by locks to test the sensitivity in the regression analysis. Where sufficient data were not available by lock, sectional averages were used. The two sets of flow factors are shown in Table C-1 in the Appendix.

The regression analysis revealed that flow factors by section of the river (north and south) had a higher correlation than those that included both lock and sectional values (see Appendix C).

3. Commercial Lockages: The commercial lockage data for each of the 28 locks came directly from Corps of Engineers PMS records. To maintain compatibility among all variables, the most recent year was used (1977).

4. Miles to the Next Lock (Above and Below the Lock): Corps of Engineers navigation charts were used to develop the miles between the locks. The river-mile value from the lock furthest upstream was simply subtracted from the river-mile value at the next lower lock. The mileage above and below a particular lock was then added together and averaged to establish the distance to the next lock.

5. Recreation Quality of Pools (Above and Below the Lock): Since no quality value was available for the pools along the Upper Mississippi River, MRI developed a rough rating scale of quality. After reviewing availability of data, two studies proved to furnish the bulk of the information necessary to establish quality in each pool. These studies included the Upper Mississippi National Recreation study, by the North Central Division, and the GREAT Recreation Facilities Inventory (1977). The subjective quality rating was based on the narrative provided in the Upper Mississippi NRA study. This rating used only three levels (poor, fair, and good) to rate the overall quality of each pool.

In addition to this subjective quality rating, four other variables were utilized to establish quality of recreation resources in each pool, surface water area in the pool, the number of public use sites, the number of sites with launching facilities, and the land above the pool and fee simple (both Corps of Engineers and the U.S. Fish and Wildlife Service Areas).

All of these values were normalized and the values were then added for each pool to establish the quality ratings. This provided a total quality rating by pool. Variable X<sub>5</sub> was simply the addition of the quality ratings above and below each particular lock. The development of the quality rating and the values derived from this analysis are shown in Table 23.

TABLE 23

## QUALITY RATINGS FOR POOLS ON THE UPPER MISSISSIPPI RIVER

Pool	1 Water Surface Area <sup>a/</sup> (acres)	2 Public Use Sites <sup>b/</sup> (number)	3 Sites with Launching Facilities <sup>b/</sup> (number)	4 Public Land in Fee Simple <sup>a/</sup> (acres)	5 Subjective Quality Rating <sup>c/</sup> (value)	Normalized Values				Overall Quality Rating
						1	2	3	4	
USAF	974	0	0	3	1	0.070	0	0	0.001	1.071
LSAF	51	0	0	3	1	0.004	0	0	0.001	1.005
1	546	1	1	20	1	0.039	0.125	0.057	0.003	1.224
2	9,652	2	13	55	1	0.692	0.250	0.736	0.009	2.686
3	17,950	7	19	3,498	2	1.286	0.875	1.075	0.590	5.826
4	35,198	16	42	6,605	3	2.522	2.000	2.376	1.115	11.013
5	10,836	10	12	4,153	3	0.776	1.250	0.679	0.701	6.406
5A	6,140	6	9	3,920	3	0.440	0.750	0.509	0.661	5.360
6	8,870	13	12	1,640	3	0.636	1.625	0.679	0.277	6.217
7	13,440	15	13	7,070	3	0.963	1.875	0.735	1.193	7.766
8	20,810	17	20	10,282	3	1.491	2.125	1.131	1.735	9.482
9	29,125	16	21	18,790	3	2.087	2.000	1.188	3.171	11.446
10	17,070	20	37	11,095	3	1.223	2.500	2.093	1.872	10.688
11	19,612	8	20	7,103	3	1.405	1.000	1.131	1.199	7.735
12	10,504	7	19	5,684	2	0.753	0.875	1.075	0.959	5.662
13	30,000	14	31	11,402	3	2.150	1.750	1.753	1.924	10.577
14	11,525	8	31	5,279	2	0.826	1.000	1.753	0.891	6.470
15	3,740	4	10	9	2	0.268	0.500	0.566	0.002	3.336
16	12,047	12	26	4,255	3	0.863	1.500	1.471	0.713	7.547
17	6,967	7	8	7,085	3	0.499	0.875	0.452	1.196	5.022
18	12,947	10	21	9,592	3	0.928	1.250	1.188	1.619	7.985
19	30,827	4	18	119	2	2.209	0.500	1.018	0.020	5.747
20	7,541	4	12	177	2	0.540	0.500	0.679	0.030	3.749
21	6,807	6	21	8,215	3	0.488	0.750	1.188	1.386	6.812
22	7,571	5	8	6,325	3	0.543	0.625	0.452	1.067	5.687
24	13,000	5	15	8,593	2	0.932	0.625	0.848	1.450	5.855
25	18,000	2	15	10,847	2	1.361	0.250	0.848	1.830	6.289
26	28,000	5	41	14,140	2	2.006	0.625	2.319	2.386	9.336
Totals	390,750	224	495	165,929	--					
Mean	13,955.4	8	17.68	5,926	--					

a/ Upper Mississippi River National Recreation Area Study (NCD).

b/ GREAT Resources Survey (February 1, 1978).

c/ Poor (1); Fair (2); Good (3)--Based on the problems/potentials narrative from the UMRNRA study.

d/ Twice the value of Pool 26.

6. Commercial Marina Slips (Upstream): This variable is the same as Variable 1 with the exception that it enumerates only commercial marina slips upstream.

7. Commercial Marina Slips (Downstream): This variable is the same as  $X_1$  with the exception it only enumerates commercial marina slips downstream.

8. Miles to Next Lock Upstream: This variable is identical to  $X_4$  with the exception that it only enumerates the number of miles to the next lock downstream.

9. Miles to Next Lock Downstream: This variable is identical to  $X_4$  with the exception that it only enumerates the number of miles to the next lock downstream.

10. Recreation Quality of Pools (Upstream): This variable is identical to  $X_5$  with the exception that it only enumerates the quality of the pool upstream from the lock.

11. Recreation Quality of Pool (Downstream): This variable is identical to  $X_5$  with the exception that it only enumerates the quality of the pool downstream from each lock.

Data for all of the variables in the regression analysis are contained in Appendix Table C-1.

### C. Small Craft Lockage Methodology

1. Multiple Regression Analysis: Using the 11 variables described above, a multiple stepwise regression analysis was performed. The outputs from the SPSS analysis are included in Appendix C. Two separate runs were made. One included the flow factor as both a lock and regional average; the second run included flow factors as only sectional averages.

The regression analysis showed that the flow factors developed on a sectional basis provided a slightly better fit than did those developed as both lock and sectional averages. This probably resulted from the statistical sample not being large enough to provide a true lock average. Thus, because some of the locks probably had slightly larger or smaller averages than the true average, they tended to distort the regression equation.

The regression analysis utilizing the sectional flow factors showed that five of the variables ( $X_{2(II)}$ ,  $X_1$ ,  $X_3$ ,  $X_{10}$ ,  $X_4$ ) do virtually as well as the whole set in predicting the Y value (pleasure boats through the lock). Specifically the equation:

$$Y = 7,601 - 2,494X_{2(II)} + 3X_1 - 0.73X_3 + 584X_{10} - 166X_4$$

has an R-value of 0.8253 while the best the set of X's can do is 0.8345. The set of variables, thus, accounts for 68 percent of the total variance in the Y values. The standard error of estimate for this equation is  $\sigma_e = 2,019$ .

Although the regression equation proved to be highly statistically significant, and represents a sizable improvement over the raw standard error of Y ( $\sigma_Y = 3,228$ ), it should be remembered that all of the data apply to the year 1977; the results, therefore, do not necessarily apply to other years. Unfortunately, this is a limitation of statistical analysis of cross-section data. Thus, the regression should be verified under similar conditions for future years to determine its usefulness in forecasting recreation lockage (see Chapter VII for recommendations).

Examination of the residuals yields no geographical trends or outlines; i.e., the remaining variability in the Y variable unexplained by the regression is more likely due to unobserved X's than it is to more complicated manipulation of the unknown X's (by a curved linear or interaction terms, etc.).

The regression analysis does show that there is a relationship for 1977 between pleasure boats through the locks and the flow of long distance travel through the locks, the surrogate of boating activity in the pools either side of the locks (commercial marina slips), the number of commercial lockages, the quality of the resources in the pools and the average distance between the locks. Thus, the regression analysis confirms the research hypotheses.

The next section develops a methodology to forecast one of the factors subject to change in the regression model (i.e., the surrogate of boating activity in the pools). Forecasts of the level of commercial lockage were provided by the St. Paul District;

it is anticipated that factor will continue to be updated periodically.<sup>1/</sup> Assuming that resource quality remains relatively constant and that mileage between the locks is unchanged, this leaves only one factor to be further manipulated by the regression model--the flow of long distance travel through the locks. Since there is no benchmark to compare the 1977 flow factor to, further analysis with this variable was not attempted. The forecasting methodology is such that this variable could be easily plugged into the model at a later date when flow trends are better understood. A recommended procedure for updating the flow factor is presented in Chapter VII.

2. Forecasting Model: Even though the regression equation explained a large portion of the variance (68 percent), and assuming that 1977 is representative of the average year in terms of recreation activity around the pools and long distance flow up and down the river, a problem still exists in obtaining data for the forecasting model. Of course, flow factors, based on the 1977 lockage survey, may be updated as project funds allow with multiple regression analysis being used to confirm this relationship. However, obtaining forecasts of boating activity in the pools for the lockage model is a major problem. It is further complicated by the fact that boating activity was not measured directly. Instead, a surrogate (commercial marina slips) was utilized as an estimator of boating activity in the pools.

MRI was previously involved in several marina studies in which a gravity model was modified for analysis of marina markets. Specifically, the model was utilized in a study for the Mobile District to evaluate markets for potential marina services and facilities along the Tennessee-Tombigbee Waterway. The model functions under a gravity construct and allocates potential boat registration for future years to available resources in a recreation system.

<sup>1/</sup> The basic approach the District used was to develop a ratio relationship between commercial tonnage and commercial lockage using an average ratio for 1976 and 1977. This average ratio was applied to the forecast of tonnage (Phase I Report: Mississippi River Year Round Navigation; U.S. Army Engineer Division, NCD, Sept. 1973.)

The gravity model was calibrated around the present supply of commercial marina slips in the 28 pools comprising the Upper Mississippi River; the outputs from this model were then used as a surrogate of future boating activity in the pools. The outputs from the gravity model are essentially the potential markets for slippage and in this respect, they are similar to the surrogate employed in the regression analysis.

The gravity model was adapted from a previous study of federal lakes in Kansas.<sup>1/</sup> Gravity models in general are based on the concept that a specific and measurable relationship exists between the number of visitors arriving at a given destination from specific markets and a series of independent variables. The most important variables usually are: (1) the size of the population in the market area, and (2) the distance between the destination and market. The model typically yields high correlation between distance to populated centers and the number of visits. Correlation with other variables such as income of the population, urbanization, highway quality and competition from other recreation areas may or may not improve the overall results of the model. These variables were not employed to forecast the potential markets for slippage on the Upper Mississippi River because of the lack of readily available data.

The general formula for the gravity model used in the Upper Mississippi analysis is:

$$T_{ij} = \frac{P_i \frac{A_j}{b}}{d_{ij}} \div \left( \frac{A_1}{b_{d_{i1}}} + \frac{A_2}{b_{d_{i2}}} + \dots + \frac{A_n}{b_{d_{in}}} \right)$$

where,  $T_{ij}$  is the potential slip market from County i to Pool j

$P_i$  is the total slip market in County i

<sup>1/</sup> Smith, Bob L., and E. D. Landman, "Recreational Traffic to Federal Reservoirs in Kansas," State Highway Commission, in Cooperation with the U.S. Department of Commerce and Bureau of Public Roads, Special Report No. 70, August 1965.

- $A_j$  is the total slip market attracted by Pool  $j$
- $d_{ij}$  is the spatial separation of County  $i$  and Pool  $j$
- $b$  is an empirically determined exponent which expresses the average areawide effect of spatial separation between zones on the amount of slip interchange. (This factor was developed from the origin/destination data developed in the 1977 recreation lockage survey.)
- $n$  is the number of Mississippi pools (28)

It may be noted that four factors are of major importance: trip productions, trip attractions, spatial distance separation, and the number of areas. Of course, the latter two are simply the distance between each county and the 28 Upper Mississippi pools, thus forming a matrix of 162 primary market counties by 28 pools (see Figure 3). The trip productions (the market generated by each county) were composed of the following specific variables:

- Population forecasts for 162 counties (1980, 1985, 1990, 1995, and 2000).
- Boat registration per 1,000 population in 162 counties for 1976.
- Growth in boat registration for five states for 1980, 1985, 1990, 1995, and 2000.<sup>1/</sup>
- Market penetration rates for 162 counties, six distance zones, and 5 years (1980, 1985, 1990, 1995, and 2000).

The population forecasts for the 162 counties were derived from the latest estimates.<sup>2/</sup> The 1976 boat registration and the forecast population for that year were used to derive the boat registration per thousand population. MRI developed future boating registration factors by examining the recent growth at state levels. The state growth rates used in the model are as follows:<sup>3/</sup>

- 1/ State growth factors for boat registration are based on overall statewide average growth.
- 2/ The county population projections provided by each of the five states incorporate the Census Bureau's latest "Series E" national population and projection and the Bureau of Economic Analysis' industrial and regional disaggregation thereof, as published in The 1972-E OBERS Projections, November 1974.
- 3/ Department of Transportation, U.S. Coast Guard, "Boating Statistics," 1966 to 1976.



GROWTH FACTORS (BOAT REGISTRATION)

<u>State</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
Illinois	1.10	1.22	1.33	1.45	1.57
Iowa	1.04	1.09	1.13	1.18	1.23
Minnesota	1.17	1.39	1.61	1.82	2.04
Missouri	1.17	1.39	1.61	1.82	2.04
Wisconsin	1.09	1.21	1.33	1.45	1.57

The result of applying the growth factors to the product of population and registration in 1976 resulted in estimated boat registration in the 162 counties for the 5 years under study.

The market penetration rates presented a much more complex problem. Obviously, a county or population center within a few miles of a lake will provide more potential use of that lake than another market center more distant. Unfortunately, no single study provides data in such specific detail as percentages of the total market by distance zones. Two previous studies were used in developing the market penetration factors. MRI previously conducted a market study at three Corps of Engineers lakes for the Little Rock District. These studies provided the overall percentage of the total market coming from various distances to the three Corps lakes.<sup>1/</sup> A previous Corps of Engineers marina market study for Shelbyville Lake in Illinois provided similar types of data for specific counties at varying distances from three marinas. Unfortunately these data were aggregated and a specific breakdown by marina was not possible.<sup>2/</sup> Using these two sources of information as a general guide, market penetration rates for six distance zones and the 5 years were developed by several gravity model calibration runs. The final market penetration rates are as follows:

- 1/ "Market Analysis for Marina Concession Facilities at Greers Ferry, Ozark and Table Rock Lakes," U.S. Army, Corps of Engineers District, Little Rock, March through June 1974.
- 2/ "A Study of the Market Potential for Small Craft Marina Concessions at Lake Shelbyville," U.S. Army, Corps of Engineers District, St. Louis (1975).

<u>Distance Zone</u>	<u>Market Penetration Rates</u>				
	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
0 to 25 miles	0.99	1.24	1.37	1.43	1.43
26 to 50 miles	0.66	0.83	0.91	0.95	0.95
51 to 75 miles	0.40	0.48	0.53	0.55	0.55
76 to 99 miles	0.20	0.25	0.27	0.28	0.28
100 to 150 miles	0.05	0.06	0.07	0.07	0.07
151 miles or greater	0.00	0.00	0.00	0.00	0.00

The potential market for a particular year was then computed as follows: the population forecast for a given year and county was multiplied by the 1976 boat registration per thousand population. This product was in turn multiplied by the boat registration growth factor for the particular year under study and resulted in the adjusted boat registration for that year. Based on the distance from the primary market county to the particular Mississippi pool in the system, the potential slip market was estimated. (Note that the total potential slip market for a county is the sum of all 28 Mississippi pools.)

The net result of using this technique for the entire market area produced the potential slip market that would be generated from the 162 counties for the 5 different years. These were the surrogate of future boating activity on the pools and were incorporated into the regression model. (The model programming documentation and coefficients are described further in Appendix D.)

The rates in the above table applied to 1980 population estimates provide a potential growth in marina slippage in the primary market area of 10 percent over the 1977 slippage. This corresponds roughly to an annual growth rate of 6 percent in boat registration which has been occurring in the 5-state area over the last 11 years. This level of activity was reached on only the second calibration run. The model allocated the potential slip market somewhat differently than the present pattern of slippage, however. Table 24 shows the present slippage and potential slip market for the 28 pools in the Upper Mississippi River. In general, the growth in boat registration primarily occurred in the upper pools. This was the result of two factors. First, population growth in the Minneapolis/St. Paul area was slightly greater than the more rural areas along the mid and lower portions of the Upper Mississippi River. Secondly, boat registration in Minnesota was almost double that in Illinois and Wisconsin and four times the Iowa rate. As a result, growth in the potential marina slippage in Minnesota was much higher than the other primary market counties.

TABLE 24

RECREATION ACTIVITY SURROGATE

<u>Upper Mississippi Pool</u>	<u>Present Commercial Marina Slippage<sup>a/</sup> (1977)</u>	<u>Potential<sup>b/</sup> Slip Market (1980)</u>	<u>Difference<sup>d/</sup></u>
USAF (51)	0	0 <sup>c/</sup>	0
LSAF (52)	0	0 <sup>c/</sup>	0
1	0	0 <sup>c/</sup>	0
2	497	1,574	1,077
3	1,562	3,303	1,744
4	1,332	1,280	-52
5	12	12	0
5A	80	77	-3
6	547	514	-33
7	46	47	1
8	909	799	-110
9	216	175	-41
10	785	614	-171
11	222	185	-37
12	1,077	813	-264
13	201	167	-34
14	627	727	100
15	318	313	-5
16	465	576	111
17	90	106	16
18	96	91	-5
19	301	264	-37
20	98	62	-36
21	250	152	-98
22	116	72	-44
24 <sup>c/</sup>	101	56	-45
25 <sup>c/</sup>	143	73	-70
26 <sup>c/</sup>	2,156	1,518	-638

a/ GREAT Recreation Facilities Inventory (1977).

b/ Output from the gravity model (1980)--also see Appendix C.

c/ Potential marina slip market at Locks 51, 52 and 1 constrained to 0.

d/ As can be noted in the text, the gravity model is based on growth in population, boat registration and other factors. The application of the model resulted in an increase in slippage at some locks (e.g., 2 and 3) and a reduction in slippage at others (e.g., 8, 10, 12, 14, 16 and especially 26). The potential slippage, therefore, is representative of market factors and does not necessarily represent the exact location where the slips will be built.

The final step in the lockage forecasting model was to convert number of pleasure boats through the locks (of the Y variable) to the number of recreation lockages. Regression analysis was again used to establish the relationship between pleasure boats through the locks and recreation lockages. The results of this analysis are also contained in Appendix E. The equation:

$$Y = 413 + 0.345X_1$$

had an R value of 0.97 (Y = recreation lockages, and  $X_1$  = pleasure boats through the locks), and it had a very close fit except for three locks with extreme values. At these locks (No. 2, 3 and 26) the large number of multiple craft lockages prevented the use of the regression equation. Therefore a different technique was applied using the 1976 and 1977 average ratio of pleasure boats through the locks to recreation lockages (see Table 25). The forecasting model (plus forecasts) and the computer program documentation are provided in Appendix E.

#### D. Forecasts of Small Craft Lockages

Utilizing the potential slip market and commercial lockage forecasts for each pool as the two variables that will undergo shifts during the next 20 years, the forecasting equation was developed around the previously described regression model. The other variables (the flow factor describing long distance river travel, a quality factor for the pools, and the distance to the next lock--above and below) were assumed to remain unchanged in future years. The results of this model produced the number of pleasure boat lockages for the 5 forecast years. These forecasts and the computer documentation are presented in Appendix E. It can be noted that negative lockage forecasts were produced for locks 22, 24 and 26. Only at these three locks was there a condition where the growth in the slip potential did not keep pace with the increases in commercial lockage. As a result, negative forecasts of pleasure boats through the locks were produced.

Before being subjected to the second part of the model (pleasure boat lockages), the forecast of pleasure boats through the locks was adjusted by a calibration factor. This factor was developed using 1977 data in the model (including both existing slips and commercial lockages) and developing multipliers that would adjust the model output to be equivalent to the current year. This factor, more or less, assumes that the lockage model accounts for all of the variance in recreation lockage. Realis-

TABLE 25

PLEASURE BOAT LOCKAGES (model)

<u>Lock</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>	<u>Actual Lockages 1977</u>	<u>No. Times Rec. Lockages Increase (2000, Compared to 1977)</u>
51	991	993	974	968	962	943	1.0
52	959	948	941	930	925	940	1.0
1	3411	4740	5993	7088	7998	1622	4.9
2	2006 <sup>a/</sup>	2971 <sup>a/</sup>	3894 <sup>a/</sup>	4696 <sup>a/</sup>	5371 <sup>a/</sup>	2570	2.1
3	2592 <sup>a/</sup>	3777 <sup>a/</sup>	4913 <sup>a/</sup>	5914 <sup>a/</sup>	6766 <sup>a/</sup>	3852	1.8
4	2697	3211	3702	4136	4504	3027	1.5
5	2191	2204	2213	2235	2253	2495	0.9
5A	2846	3169	3458	3722	3935	3478	1.1
6	2443	2631	2838	3028	3183	2931	1.1
7	3395	3866	4282	4648	4945	3544	1.4
8	2100	2409	2681	2920	3113	2594	1.2
9	2460	2758	3011	3240	3424	2599	1.3
10	3299	3744	4122	4457	4730	4397	1.1
11	2305	2713	3044	3347	3595	2658	1.4
12	1570	1941	2237	2516	2746	2354	1.2
13	2659	3013	3292	3557	3791	2178	1.7
14	3378	4028	4521	4998	5413	3101	1.7
15	2243	2898	3340	3795	4185	2818	1.5
16	1147	1270	1356	1446	1522	1310	1.2
17	971	997	1008	1033	1053	1270	0.8
18	871	930	1041	1119	1186	1418	0.8
19	689	745	781	817	848	667	1.3
20	506	502	520	528	536	705	0.8
21	737	734	752	735	768	980	0.8
22	477	459	432	413	413 <sup>b/</sup>	776	0.5
24	413 <sup>b/</sup>	413 <sup>b/</sup>	413 <sup>b/</sup>	413 <sup>b/</sup>	413 <sup>b/</sup>	895	0.5
25	1954	2962	3901	4852	5755	1128	5.1
26	212 <sup>a/b/</sup>	212 <sup>a/b/</sup>	212 <sup>a/b/</sup>	216 <sup>a/b/</sup>	260	329	0.8

a/ Lockage Conversion Factors

- 2 - Rec. Lockages x 0.319
- 3 - Rec. Lockages x 0.337
- 26 - Rec. Lockages x 0.514

b/ Pleasure boats through

locks corrected for negative numbers  
in the model (Pleasure boats = 0).

tically it should be recognized that calibration factors should be computed periodically to determine if they are subject to major shifts. In general, it was noted that the calibration factors improved the outputs (i.e., the forecasts appeared more realistic in light of the existing lockage pattern).

The forecast of the number of recreation lockages for 1980, 1985, 1990, 1995, and 2000 is presented in Table 25. Overall there is a net decrease of 6,451 recreation lockages on the Upper Mississippi River forecast for 1980 compared to 1977--a net change of 11 percent. This is because of two changes in variables in the equation--the potential slip market and commercial lockage forecast. This decrease means that increasing commercial traffic may outweigh increases in boating activity (the potential slip market being a surrogate of boating activity).

Using 1977 recreation lockage as a base and comparing the 2000 forecast shows some interesting trends. For example, many of the locks show little change during the 20-year period. In many instances, forecasts for the year 2000 are nearly the same as 1977 lockage. The increases, in general, occur around major metropolitan areas near Minneapolis/St. Paul, La Crosse, Wisconsin, the Quad-cities area and St. Louis to the south. For instance, the 2000 forecast for locks 1, 2, 3, and 4 all show more than a 1-1/2 times increase over 1977; Lock 7 (La Crosse, Wisconsin) is forecast to increase by 1.4 times; Locks 13, 14, and 15 all show increases of more than 1-1/2 times by the year 2000; and on the lower end of the river, Lock 25 shows an extremely large increase over 1977.

Although both 1 and 25 show large increases, it should be remembered that the gravity model forces slippage into the nearest available pool to population origins. These pools undoubtedly received the lion's share of the potential slip market from the Minneapolis/St. Paul and St. Louis areas. In reality, on the upper end of the Mississippi (because of resource characteristics and quality) much of the demand for slippage will be expended in Pools 2 and 3. Thus, the 4.9 times increase at Lock 1 will probably be distributed between Locks 1, 2 and 3. On the lower end of the river, it should be remembered that commercial lockages at Pool 26 are forecast to increase by more than 10,000 during the next 23 years. No other lock on the Upper Mississippi River comes near this figure. As a result, recreation lockages that might normally be expected are greatly reduced. Otherwise, instead of actually showing a decrease by the year 2000, recreation lockage at Lock 26 would probably increase.

Finally, it should be remembered that both the potential slip market and the commercial lockage variables are forecasts. Since there was no future estimate of slippage by pool (the surrogate of boating activity), this gravity model output was interfaced with the regression equation to evaluate potential slip markets. By adding this dimension, the forecasting model incorporates two major variables affecting boating activity, population-growth and rates of change in boat registration. Essentially the gravity model takes the potential market from 162 counties and allocates it among the 28 pools, with present slippage representing the indicator of quality.

Of course, the forecast of commercial lockage is based on a similar type of trend analysis and will be affected by a great many changes in the economy in future years. Although the gravity approach to forecast slip market may provide a more realistic pattern of future slippage than a simple forecast of slip locations, and the commercial lockage forecast is based on the best data available at this time, there is no way of evaluating their future accuracy, not to mention variation introduced in the model by unaccounted for variables. A later chapter (VII) recommends updating the model periodically and provides a simplified procedure for collecting the necessary data.

With these limitations in mind it appears that the greatest increases in lockage will occur near the Minneapolis/St. Paul area the Quadcities area, and near St. Louis. Some of the smaller metropolitan areas such as La Crosse, Wisconsin, Dubuque, Iowa, and Quincy, Illinois etc., may also experience some increase. In general, the forecasting model supports the basic survey finding that implies that major conflict areas will probably be on weekend afternoons at locks near metropolitan areas.

## CHAPTER VI

### METHODOLOGY AND FORECASTS OF RECREATION USE

One of the variables that MRI hypothesized as having an effect on recreation lockage was the amount of boating and other water-oriented activities taking place on each pool. This seems likely since the surrogate of boating activity and the long distance flow factor were two of the most important variables in the multiple regression lockage model. Unfortunately, there are few reliable data available describing the level of recreation activity (i.e., boating); and in order to test a relationship by regression analysis or some other statistical technique, the information would have to be available by pool.

The Recreation Resources Management System (RRMS) does provide an estimate of visitation at each pool. The type of activity is estimated as a percent of the total activity. These data were examined, and it was noted that pools having the highest activity often had the very lowest recreation lockage. Because the RRMS visitation data are not generally considered accurate for planning purposes, they were not subjected to further analysis.

Since the general thrust of the study was on developing a model to forecast recreation lockage rather than recreation activity on each pool, general alternative forecasting approaches were taken. Essentially forecasts of recreation activity were provided for six river use zones along the river. These forecasts included:

- \* SCORP forecasts for five different water related activities.
- \* RRMS aggregate zone use as a percent of SCORP zone participation activity.
- \* Forecast of recreation use using a modified "similar project" technique.

A. Recreation Activities Related to Small Craft Lockages

1. Recreation Activity Participation Trends: Underlying the increasing utilization of public and private sector recreation resources is the changing recreation activity participation patterns of the American public. Numerous studies have discussed the association between participation and social and economic factors. Clawson and Knetsch feel that the four factors having the greatest effect on the demand for outdoor recreation are: growth in our population, the availability of leisure or free time, the increasing mobility in our modern society, and the disposable income people have to spend for outdoor recreation.<sup>1/</sup>

Other population factors such as age, sex, and race also affect participation. Young people tend to participate in active sports, while older individuals are interested in more passive activities. Women tend to participate less in the more aggressive and active types of sports than men. Also, racial and ethnic groups often have their own activities that are greatly influenced by culture and background. As the internal structure of our population changes, these various factors will have an impact on the type of recreation activities that will be pursued.

Leisure time and the 4-day workweek have received a great deal of publicity during the last few years. Many feel that leisure is increasing and it will have a great impact on future outdoor recreation participation. Indeed, the 4-day workweek enables people to have one more day to do as they please. But there are also problems associated with implementing the concept on a massive societywide basis. At least one authority has said that, in fact, the average American has no more free time than his great grandfather had 100 years ago.<sup>2/</sup> Whatever the case, recreation specialists generally agree that the size of blocks of leisure time and their timing have an important bearing on participation. Since our society appears to be headed toward longer weekends, increases in visitation to recreation resources near metropolitan areas could be substantial.

<sup>1/</sup> Clawson, Marion, and Jack L. Knetsch, "Economics of Outdoor Recreation," published for Resources for the Future, Inc., by Johns Hopkins Press, Baltimore, Maryland (1966).

<sup>2/</sup> DeGrazia, Sabastian, Of Time, Work, and Leisure, Anchor Books, Garden City, New York (1962).

Total personal income also has an effect on the quantity and types of outdoor recreation that are pursued. During the last 50 years, recreation expenditures have steadily increased as a percentage of total personal consumption expenditures. According to Department of Commerce figures, expenditures in the "recreation" category have grown from approximately 3 percent of total personal consumption expenditures in the 1920's to over 6 percent at the present time. Since total aggregate personal consumption expenditures have also increased significantly during this period, both in current and constant dollars, total recreation expenditures have grown at a considerably higher rate than total personal consumption expenditures. Moreover, Department of Commerce figures for recreation spending do not include many elements of spending that are specific to leisure and recreation. Some research data developed recently indicate that leisure-specific expenditures had reached just slightly under 10 percent of total personal consumption expenditures by 1973.<sup>1/</sup>

Jensen discusses several other factors having an effect on outdoor recreation participation.<sup>2/</sup> He believes that the ugliness and congestion of urbanization is driving people to rural areas for recreation. Jensen also feels that modern automation and technology have an impact on what people do in their spare time. Since many are tied to desks or employed in repetitive, trivial types of work activities, their outdoor leisure time gives them an opportunity for creativity. Better education also enables people to have a deeper appreciation for nature and history. These and other social changes have caused our nation to move from:

"--feudalism, based on a stable agricultural society, through industrialism, based on a system of mass production, to a highly livable era characterized by freely disposable time and materials."<sup>2/</sup>

The social and economic factors listed above are only some of the complex variables influencing participation in outdoor recreation activities.

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<sup>1/</sup> Leisure/Recreation Market Research Program, Midwest Research Institute (1974).

<sup>2/</sup> Jensen, Clayne R., Outdoor Recreation in America, Burgess Publishing Company, Minneapolis, Minnesota (1970).

There have been only four major surveys of recreation participation conducted at the national level. Table 26 presents a comparison of annual per capita participation rates for similar types of recreation activities. Recognizing that each survey was conducted by different personnel utilizing unique research techniques and definitions, these data nevertheless show dramatic increases in participation for several recreation activities. These activities include water-related activities (boating, water skiing, and fishing). In general, most recreation activities have become more important to the average American citizen during the past 10 to 15 years.

TABLE 26

RECREATION PARTICIPATION TRENDS--1960 TO 1972<sup>a/</sup>

<u>Activity</u>	<u>Year</u>			
	<u>1960<sup>b/</sup></u>	<u>1965<sup>c/</sup></u>	<u>1970<sup>d/</sup></u>	<u>1971/72<sup>c/</sup></u>
Attend Outdoor Concerts, Drama, Sports Events, etc.	4.0	5.5	3.6	13.0
Bicycling	5.1	9.5	6.6	16.9
Boating	1.9	1.6	2.5	3.3
Camping	0.9	1.3	2.3	2.1
Driving for Pleasure	20.7	20.7	--	27.2
Fishing	4.2	2.3	3.3	6.8
Horseback Riding	1.3	1.6	1.1	2.1
Picnicking	3.5	5.3	3.0	8.9
Playing Outdoor Games	12.7	23.3	12.2	25.6
Sightseeing	5.9	8.7	--	6.8
Swimming	6.5	6.9	9.2	18.1 <sup>e/</sup>
Walking for Pleasure	17.9	30.2	11.2	23.4
Water Skiing	0.4	0.4	--	1.1

a/ Differing survey techniques and definitions preclude any but qualitative year-to-year comparisons.

b/ Outdoor Recreation Resources Review Commission.

c/ U.S. Department of Interior, Bureau of Outdoor Recreation.

d/ Midwest Research Institute.

e/ Includes indoor and pool swimming.

2. Water-Related Recreation Activities (A National Perspective): Six recreation activities are probably related to small craft lockages on the Upper Mississippi River and may serve as motivations of river users to transfer from one pool to the next. These activities included:

- Boating
- Fishing
- Swimming
- Water Skiing
- Canoeing
- River Running<sup>1/</sup>

Boating in general over the past 15 years has been increasing, although the average annual growth rate in boat ownership in the last decade has been a scant one-half of 1 percent over population growth. The most remarkable change in boat ownership has occurred in horsepower. In 1950, the average horsepower of motors sold was 6.9. By 1960, the horsepower level had reached 27.4; in 1970, it was 31.0 and by 1976 it was 42.1. The average increase in per capita participation for boating shown in Table 26 is slightly over 7 percent annually. The 1965 BOR study projected boating participation to increase during the period from 1965 to 1980 at 5.1 percent annually, and from 1965 to 2000 at a rate of 6.1 percent annually. By 1975, the BOR revised boating participation slightly downward to an annual percent increase of 3 percent. It was estimated that nearly three-fourths of boating occasions occur on weekends, and the average number of hours of participation per day is 2.8. The average participation for an activity day of sailing is 4.4 hours.<sup>2/</sup>

<sup>1/</sup> A boating experience of extended duration in which several pools or significant stretches of the Mississippi River are traveled.

<sup>2/</sup> Outdoor Recreation, A Legacy for America, Bureau of Outdoor Recreation, U.S. Department of Interior (1972).

Boating may very well be an activity that has reached its peak in attracting new clientele. The ownership statistics seem to indicate that nationally the primary market is in terms of replacement rather than selling new craft. Nevertheless, boating activity will continue to increase, depending somewhat on the energy crisis, and will continue to affect lockage on the Upper Mississippi River.

Fishing on the other hand has tended to be a rather stable activity with only moderate increases during the past decade. The annual percent increase in fishing activity indicated in Table 26 is about 6.1 percent. The Bureau of Outdoor Recreation (BOR), both in their earlier study in 1965 and as a result of the 1972 survey, projected fishing to increase at an annual rate of about 2 percent. As was shown by the recreation lockage survey (1977) about one-fourth of all boaters participated in fishing during their boating trip. The BOR estimates that about 68 percent of fishing in general occurs on the weekends and the average trip last 4.4 hours.<sup>1/</sup>

Swimming may only affect recreation lockage on some pools. Not only is river swimming somewhat dangerous, the water quality of some of the Mississippi pools is such that it may tend to discourage participants. It was noted from the lockage survey, however, that over 70 percent of the boaters would swim during their river experience (see Table 9). This seems to indicate that most boaters either do not consider water quality as bad, or ignore it as a factor. Nevertheless, nationally swimming is projected to increase at an annual rate of 2 percent.<sup>1/</sup>

Perhaps water skiing is the water-oriented activity that has shown the most potential for growth at the national level, although earlier projections by the BOR have been revised downward. The continued increase in the average horsepower of boats being purchased no doubt has a relationship to water skiing. The BOR estimates that 69 percent of all water skiing takes place on weekends, and the average experience lasts about 2.6 hours.<sup>1/</sup>

Canoeing is an activity that only recently attracted attention at the national level and was thus included as an activity in the most recent National Recreation Survey. While it has become very important, particularly in mountain areas where there are outstanding resources, it appears to be unimportant as far as the Upper Mississippi River is concerned. Out of a total of 1,464

<sup>1/</sup> op. cit. (1972).

recreation boats passing through the locks during the survey, only one was a canoe. No doubt the presence of larger boats, not to mention barges and rather large locks with a chasm-like appearance inside, have some discouraging effect on canoers.

River running is defined as a boating experience of extended duration, in which several pools or significant stretches of the Mississippi River are traveled. This activity has been described in some detail in Chapter IV. The survey results, however, present participation only for one point in time (summer 1977). As will be shown in the next chapter, river running also had a statistical significance in the regression analysis. Since this factor will be affected by the availability and price of fuel, the Corps of Engineers should pay close attention to river running in future years.

A major question in the future will be, "what affect will delay time have on recreation lockage? Will boaters tend to stay in one pool and transfer their craft to other pools by trailer, or will they continue to compete with commercial traffic?" The MRI survey shows that there is some concern, and the regression analysis (see Chapter V) did reveal that the level of commercial traffic at locks does impact on recreation traffic.

A number of other questions are yet to be answered, such as, "How will recreation lockage be affected by use of the dredge-material islands?" The lockage survey indicated that already 38 percent of the users were camping on dredge-material islands.<sup>1/</sup> A number of these boaters were traveling long distances from the south to reach these islands. If this type of use increases in the future, it will place a heavier burden on the locks.

Another question is "How will the location of access facilities affect recreation lockage?" It might be hypothesized that if enough access facilities (e.g., launching ramps, etc.) were located near population areas, and particularly in pools with dredge-material islands and other quality recreation resources, it might reduce the number of recreation lockages required to travel on the river to these areas. However, the survey indicated that a majority of the larger boats using the dredge-material islands are moored at commercial marinas and travel long distances to reach these resources. It is doubtful that these owners will haul their boats by road to reach superior resources.

<sup>1/</sup> Preliminary findings from the University of Wisconsin study on the Upper Mississippi River indicates that 32.2 percent of the dredge-material island users also used the locks (survey Summer 1977).

Other questions to be answered relate to the public's knowledge of lockage facilities and perceptions about safety that nonusers have regarding the lockage facilities. For instance, "How would the public react to a large-scale Corps of Engineers promotion program advertising the availability of the locks and instruction on how to use the locks safely?" Such a program could have a great impact in areas already heavily burdened by recreation traffic. Finally, "what affect would user fees have on recreation lockage?" These and other questions will have to be answered by future research (see recommendations in Chapter VII).

The St. Paul District sponsored another study in summer 1977, that involved a survey of registered boaters in several states. Although the study was primarily oriented to evaluating feasibility of marina facilities on Lake Superior, a portion of the survey was devoted to boating on Lake Pepin (Pcol 4). Conducted by Roy F. Weston, Inc., a mail survey of 2,200 registered boaters revealed interesting parallels to the recreation lockage study.<sup>1/</sup> A total of 9.3 percent of the respondents indicated they had operated their boat on the Upper Mississippi River during the summer. Of those, 26 percent said they had boated on Lake Pepin. When asked why they did not operate their boat on Lake Pepin, the two most important reasons were: no interest in boating there and the lake is located too far from their residence (see Table 27).

TABLE 27

REASONS FOR NOT OPERATING A BOAT ON LAKE PEPIN

	<u>Percent</u>
Too far from residence	32.5
Boat size unsafe for Lake Pepin	5.0
Convenient launching facilities not available	1.1
No interest	44.4
No permanent storage facilities available	1.7
Other	<u>15.3</u>
Total	100.0

Source: Roy F. Weston, Inc.

<sup>1/</sup> The Weston survey design included only those counties identified as potential market areas for western Lake Superior and Lake Pepin.

The Upper Mississippi boater primarily came from Minnesota (77.1 percent); a total of 12.7 percent came from Wisconsin, 9.1 percent from Iowa, and only 0.1 percent from Michigan. A large portion of those using the Upper Mississippi were piloting craft that had an outboard motor (68.8 percent). A total of 12.5 percent had inboard-outdrive craft, and 8.5 percent were piloting craft with inboard motors. When asked how they gained access to Lake Pepin, 57.3 percent said they had trailered their boat from home and launched it on Lake Pepin or in a nearby pool. A total of 26.7 percent indicated their boat was moored at a commercial marina, boating club, yacht club or publicly owned marina with direct water access. Dry storage at a facility with direct access to the river provided access to 2.6 percent of the respondents (see Table 28).

TABLE 28

ACCESS TO LAKE PEPIN

	<u>Percent</u>
Commercial marina, club, public owned facility	26.7
Private slip	4.7
Dry storage	2.6
Trailered from home	57.3
Other (primarily river running)	<u>8.8</u>
	100.1

Source: Roy F. Weston, Inc.

The origin of their home port or launching point was also quite interesting. Twenty-one percent of the respondents were either moored in Lake Pepin or had launched their craft there. Seventy-nine percent indicated access beyond Lake Pepin, showing that a large portion of those using the lake had used the locking facilities in order to gain access to the lake. However, when cross-tabulated with a question about the use of the river locks, only 53.3 percent indicated they had used them. Most of those with a negative response indicated they were either not interested or they had smaller boats and trailered in. When cross-tabulated with the access question, it was learned that 75 percent of those moored at a commercial marina or utilizing a private slip used the locks. On the other hand, 60 percent of those trailering boats to Lake Pepin indicated they had not used the locks. "Chi-square" analysis revealed this relationship was significant. This also compares to a similar finding from the MRI lockage survey which showed the larger moored boats traveling longer distances tended to be those most likely to use the locks.

As with the lockage survey, the Weston study seems to imply that the primary source of demand for recreation lockage in future years will be the larger boats moored on the river. They are less mobile and thus, owners will use the river and locks to travel to recreation areas with quality resources and facilities. It could be interesting to find out how many dredge-material users (the GREAT Recreation Survey) are using lockage facilities. From the findings revealed in the MRI survey and confirmed by the Weston survey, it appears that the percentage could be quite high.

Two other studies may hold a partial answer to some of the questions discussed above. These studies include the Mississippi River Recreation Survey (sponsored by the GREAT) and the Lower St. Croix River Recreation Survey. Both studies are scheduled for publication in early 1978. Hopefully a few of the answers will be contained in the results.

#### B. Current Usage and Forecasts of Recreation Activity

For purposes of recreation use analysis the study area was divided into six zones along the Upper Mississippi River. The selection of these zones was guided by the already existing SCORP regions and the need for data in the analysis. The location of major metropolitan areas along the river was also a factor. Figure 4 visually depicts the use zones. A brief verbal description of each zone follows:

- Zone 1--Minneapolis/St. Paul: Study area above Upper St. Anthony Falls to Lock and Dam 3. It includes Upper and Lower St. Anthony Falls and Pools 1, 2, and 3; it is bordered by Minnesota SCORP Regions 7 and 11 and Wisconsin SCORP Region 13.
- Zone 2--Winona/LaCrosse: Lock and Dam 3 to Lock and Dam 9. It includes Pools 4, 5, 5A, 6, 7, 8, and 9 and is bordered by Minnesota SCORP Region 10 and Wisconsin Regions 4 and 12.
- Zone 3--Dubuque: Lock and Dam 9 to Lock and Dam 13. It includes Pools 10, 11, 12 and 13 and is bordered by Iowa SCORP Region 1 and Wisconsin Region 3 and Illinois Region 1A.
- Zone 4--Quadcities: Lock and Dam 13 to Lock and Dam 19. It includes Pools 14, 15, 16, 17, 18, and 19 and is bordered by Iowa SCORP Regions 2 and 3 and Illinois Region 1B.

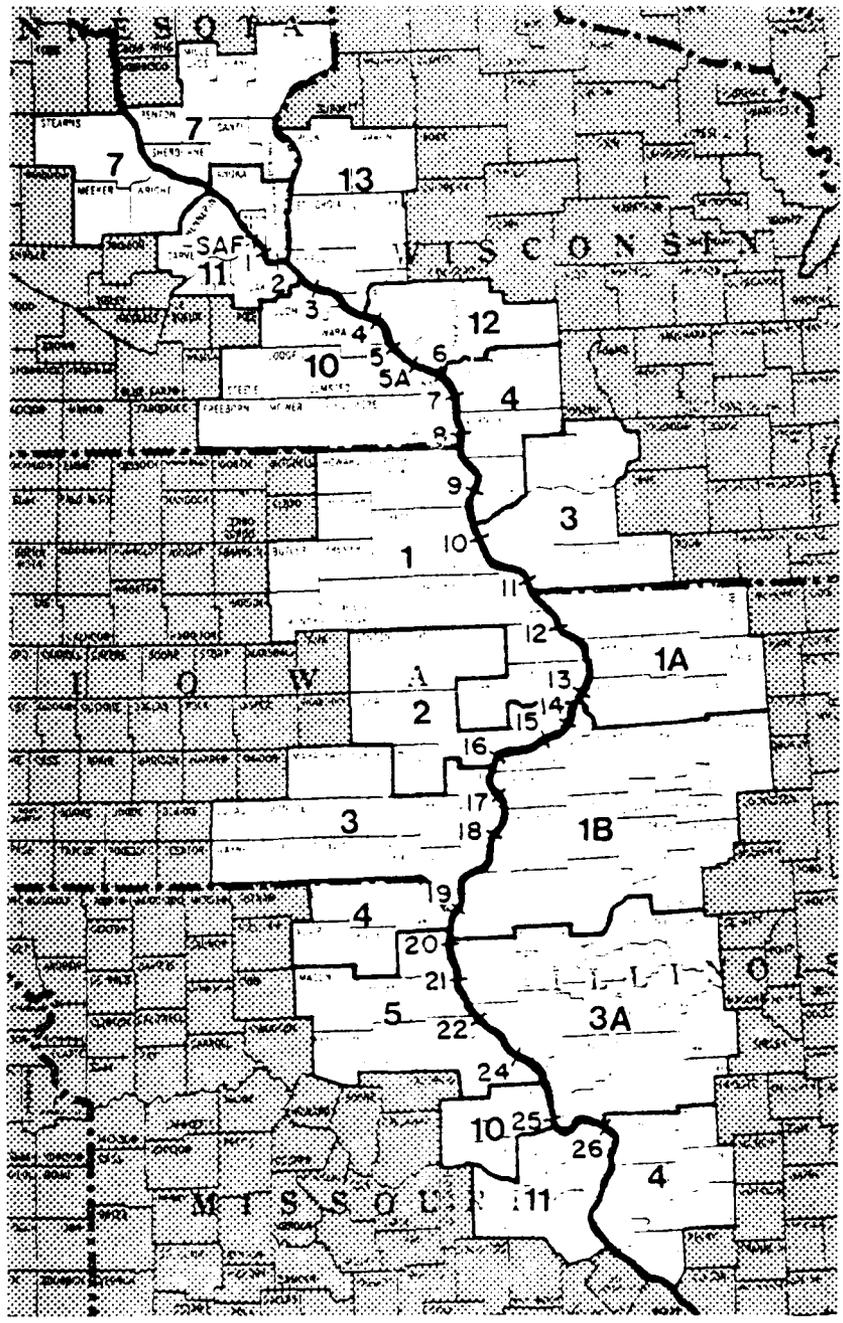


Figure 4 - SCORP Regions Adjacent to the Upper Mississippi River

- Zone 5--Quincy/Hannibal: Lock and Dam 19 to Lock and Dam 25. It includes Pools 20, 21, 22, 24, and 25 and is bordered by Missouri SCORP Regions 4, 5, and 10 and Illinois Region 3A.
- Zone 6--St. Louis: Lock and Dam 25 to southern end of study area. It includes Pool 26 and is bordered by Missouri SCORP Region 11 and Illinois Region 4. Pool 26 was separated from Zone 5 because of its uniqueness (highest commercial lockage, lowest recreation lockage).

1. Current Recreation Visitation: Data on current recreation use of the Upper Mississippi River is available from the Corps' Recreation Resource Management Systems (RRMS). The figures in Table 29 show 1976 recreation days of use by pool and percent of total visitors participating in boating, fishing, swimming, and water skiing. Although the accuracy of these data is questionable, they provide the only trend information on recreation visitation for all 28 pools comprising the Upper Mississippi River.

The greatest number of recreation days of use in 1976 was experienced at Pool 26--3,939,200 recreation days. Together with Pool 25, over 5 million (5,335,500) recreation days were recorded on the river directly above the St. Louis Metropolitan Area. Pool 13 received 3,025,600 days of recreation use. Combining Pools 12, 13, and 14 results in another 5 million (5,167,900) days of recreation use between Dubuque and the Quadcities. The third highest area of recreation use in 1976 took place on Pool 21 in the Quincy, Illinois area--2,418,100 days.

The greatest percent of boating activity did not necessarily coincide with the pools having the greatest number of recreation days. The activity percentages in Table 29 suggest different pools attracted different types of activity use. The largest portion of total activity in boating was recorded at Pool 4, with 75 percent participation. This compares with 70 percent at Pool 2 and 65 percent at Pool 5A, the second and third ranking pools. Overall, a larger portion of the total activity was in boating on northern pools; the greatest number of boating days, however, was on southern pools.

Rock Island District pools experienced around 50 percent participation in fishing in 1976, and 40 percent of the visitors to Pools 1, 3, and 5A participated in fishing.

TABLE 29

1976 VISITATION TO POOLS ON THE UPPER MISSISSIPPI RIVER

Pool	Recreation Days of Use <sup>a/</sup>	Activity Use in Percent			
		Boating	Fishing	Swimming	Water Skiing
U & L SAF	82,500	60	10	5	5
1	92,100	50	40	1	0
2	318,700	70	10	0	10
3	530,500	60	40	5	10
4	554,600	75	25	10	20
5	190,400	50	10	5	25
5A	256,700	65	40	10	10
6	560,500	60	20	10	20
7	333,000	60	20	15	20
8	478,700	50	25	5	10
9	498,200	50	20	5	5
10	371,400	45	10	10	10
11	642,800	30	50	2	2
12	1,392,400	30	50	2	2
13	3,025,600	30	50	2	2
14	749,900	30	50	2	2
15	419,000	30	50	2	2
16	1,153,200	30	50	2	2
17	653,400	30	50	2	2
18	735,800	30	50	2	2
19	1,855,400	30	50	2	2
20	145,200	30	50	2	2
21	2,418,100	30	50	2	2
22	1,112,700	30	50	2	2
24	502,419	21	35	26	9
25	1,396,300	21	35	26	9
26	3,939,200	21	35	6	9

Source: Corps of Engineers Recreation Resource Management Systems.

<sup>a/</sup> 1976 instead of 1977 data appear in this table, because the original analysis took place in September 1976 and 1977 data were not yet available.

Data from RRMS suggest river swimming in 1976 was most prevalent in Pools 24 and 25, as 26 percent of visitors participated. Pool 7 had 15 percent participation while 10 percent swimming use was recorded at Pools 4, 5A, 6, and 10.

The stretch of the river between Red Wing and LaCrosse had the greatest percentage of total use in water skiing. One-fourth of the visitors to Pool 5 water skied while Pools 4, 6, and 7 attracted 20 percent participation.

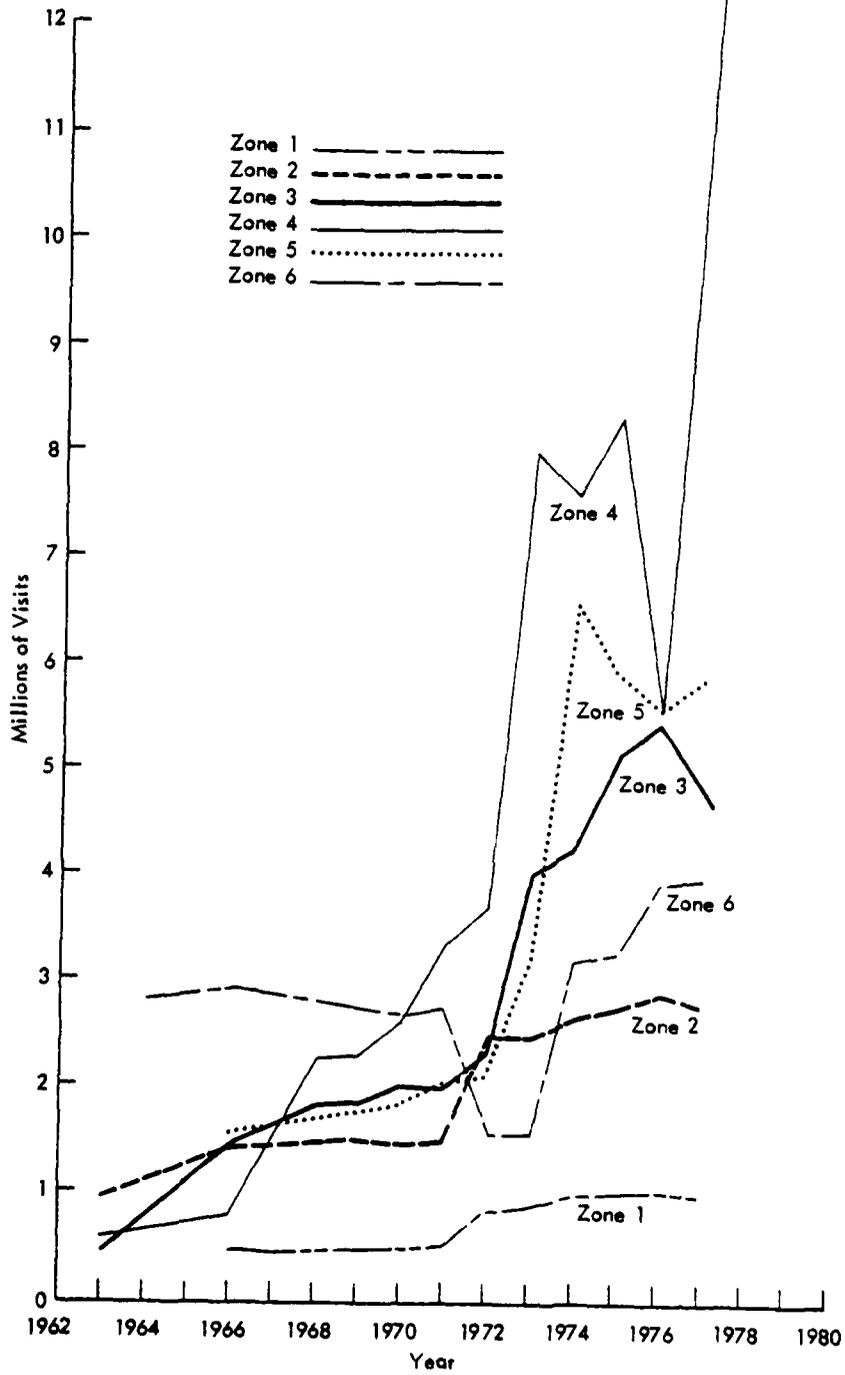
By combining the percentages for the four activities, Pool 4 stands out as the most attractive in terms of multiple activity usage. Following Pool 4 in multiple activity usage are Pools 5A, 3, and 7.

2. Trends in Visitation: The RRMS data reflect visitation trends for the 28 pools. For purposes of analysis, the individual pool data have been aggregated into the six zones and are presented in Appendix Table F-2. Figure 5 visually depicts the visitation trends by zone over the past 15 years.

The graph clearly reveals Zone 1 as the least active in recreation day use, with a slow steady rate of growth over the 4 years, 1972 to 1976. Zone 1 growth over the 4 years was 26 percent, while the Upper and Lower St. Anthony Falls and Pool 1 were around 90 percent. Boating and swimming activity remained fairly constant over the period, but fishing and water skiing activity dropped 5 percent each.

Zone 2 also showed a slow steady growth trend between 1972 and 1976, increasing 19.3 percent. While attracting the fewest recreation days, Pool 5 visitation jumped over 200 percent from 1972 to 1976. The remaining pools in Zone 2 experienced growth between 6 and 20 percent for the period. Activity in swimming and water skiing remained constant, while boating participation picked up slightly and participation in fishing dropped to 23 percent in 1976.

Zone 3 experienced the greatest growth from year to year resulting in a 130 percent increase from 1972 to 1976. The pools with the greatest number of recreation days had the greatest percentage increases. Individual pool growth over the 4 years was: Pool 10, 5 percent; Pool 11, 92 percent; Pool 12, 147 percent; and Pool 13, 172 percent. Boating, fishing, and swimming activity in Zone 3 peaked in 1975 and then dropped in 1976, while water skiing participation was fairly constant. There was a sharp drop in visitation for Zone 3 in 1977 (14.5 percent from the 1976 high).



Source: Corps of Engineers RRMS

Figure 5 - Corps of Engineers Visitation Trends by Zone Along the Upper Mississippi River

Visitation to Zone 4 was consistently higher than any of the other five zones until 1976 when visitation was matched by Zone 5. Between 1972 and 1976, recreation days of use increased 50 percent. After declining sharply in 1976, aggregate zone use increased to a high of over 12 million in 1977 (an increase of 55 percent over the previous year). The erratic trend was due to visitation patterns at all pools, particularly 16 and 19. Activity use was equally variable. Participation in boating climbed steadily; fishing activity rose, except for a 1 percent slip in 1974; and swimming and water skiing dropped in 1976.

Zone 5 experienced a very large increase in visitation between 1972 and 1976, although it peaked in 1974 and declined until 1977. Responsible for the 162 percent increase between 1972 and 1976 were Pools 21 and 22 both of which showed a tripling of recreation days over the 4-year period. Boating, fishing, and water skiing activity patterns all dropped in 1973 and have slowly risen through 1976; however, they have not recovered the 1972 participation rate. In contrast, participation in swimming picked up in 1976.

Zone 6 which consists solely of Pool 26, had a 45 percent increase in recreation days of use between 1972 and 1976. Figure 5 indicates there was no set pattern to recreation use over the previous 4 years, although there was a large decrease between 1971 and 1974. Participation trends were more defined as boating activity steadily declined between 1972 and 1976; fishing remained around 30 to 35 percent; and swimming and water skiing fell in 1973; the swimming percentage increased sharply in 1977 to 21 percent.

3. Forecasts of Recreation Use in SCORP Regions: Public demand for river-related recreation activities will most likely affect recreation craft lockages on the Upper Mississippi. Unfortunately, it was not within the scope of work of this study to determine how much of that recreation demand will be satisfied on the Upper Mississippi River. Therefore, it is imperative to interpret these estimates as total demand within the SCORP region and not the demand for a particular resource.

As was discussed previously, the six zones along the Mississippi River defining the use area were comprised of SCORP regions. The zones and corresponding SCORP regions were as follows:

Zone 1--Minnesota Regions 7 and 11; Wisconsin Region 13

Zone 2--Minnesota Region 10; Wisconsin Regions 4 and 12

Zone 3--Iowa Region 1; Wisconsin Region 3; Illinois Region 1A

Zone 4--Iowa Regions 2 and 3; Illinois Region 1B

Zone 5--Missouri Regions 4, 5, and 10; Illinois Region 3A

Zone 6--Missouri Region 11; Illinois Region 4

A complete list of SCORP regions and their corresponding counties can be found in Appendix Table F-1.

a. Methodology: The demand for outdoor recreation is influenced by several factors. Demographic and socioeconomic factors include growth in population and shifts in age, income, and education levels. Other factors include increased leisure and mobility and attitudinal changes. Unfortunately, many of the data are not available or not quantifiable for forecast use. Underlying most forecasts of recreation demand (i.e., participation) are two factors: (1) population projections; and (2) per capita participation rates.

Appendix Table F-3 gives the population projections by SCORP region and use zone for the years 1980, 1985, 1990, 1995, and 2000. Participation rates were developed by defined age groups (e.g., for Iowa, activities participated in by persons 12 years of age or over). Thus, population projections are also for particular age groups.

Recreation economists at MRI have followed participation data in outdoor recreation for 17 years. By monitoring changes over the years, MRI has developed demand growth factors by activity, which allow some degree of judgment as to the overall effects of the above-mentioned factors. Table 30 gives a comparison of participation rates derived from several recent studies. Recent growth per year figures were computed and compared. Then percent

TABLE 30

DEVELOPMENT OF PARTICIPATION GROWTH FACTORS

Activity	Percent Change Per Year		Percent Change Per Year		BOR, 1965b/		MRI		Iowa	Illinois
	1960a/ 1965b/ 1970c/ 1970d/	1970 MRI L/R	1960 ORRC to 1970 MRI L/R	BORc/ Per Year	1965-1980 %/Year	1965-2000 %/Year	1970-1980 %/Year	1980-2000 %/Year	%/Year 1966-1975 SCORP	%/Year 1970-1976 SCORP
Boating	1.94	2.50	3.31	7.1	5.1	6.1	5	6	9.1	12.3
Fishing	4.19	2.28	3.32	6.2	2.1	2.2	2	2	7.6	--
Swimming	6.47	6.86	9.17	18.0	4.8	5.9	5	6	8.4 (other)	3.1
Water Skiing	0.41	0.40	--	1.13	8.1	10.4	8 f/	10	--	--
Canoeing	--	--	--	0.27	--	--	8 f/	10 f/	--	19.0

a/ Outdoor Recreation Resources Review Commission (year round) (ORRC).

b/ BOR (summer only) 1965.

c/ BOR, 1970 Survey of Outdoor Recreation Activities (year round).

d/ MRI Opportunities in the Leisure Industry Study (year round).

e/ BOR, 1972 Outdoor Recreation, A Legacy for America (Appendix A).

f/ Canoeing:

Iowa percent per/year, 1966 SCORP, 1975 SCORP: 19.0

1970 L/R to Average of Three State Rates, 1970-1975, percent

per/year: 15.8

1970 L/R to 1975 Iowa Rate, percent per/year: 10.0

DEMAND GROWTH FACTOR (Z)\*\*

Activity	1970	1980	1985	1990	1995	2000
Boating	100	140	165	190	215	240
Fishing	100	110	115	120	125	130
Swimming	100	140	165	190	215	240
Water Skiing	100	170	215	260	305	350
Canoeing	100	170	215	260	305	350

** Year	Population	Percent Change
1970	203,213,000	--
1980	223,532,000	10
1990	246,039,000	21
2000	270,726,000	31

Assume a 1 percent increase in population per year which is deducted from growth factors.

per year growth figures were derived for the years 1970 to 1980 and 1980 to 2000.<sup>1/</sup> The year 1970 was used as the base year in calculating the demand (participation) growth factors. Before the actual computations were made, the data were adjusted downward to reflect population growth and, therefore, eliminate that portion of participation directly dependent on growth in population. Population was assumed to increase 1 percent per year. Therefore, if total boating participation was assumed to increase 5 percent per year between 1970 and 1980, 10 years times 5 percent equals 50 percent minus 10 percent growth in population equals 40 percent. The growth factor for boating in 1980 would be 140, with 1970 (the base year) equal to 100. Forecasts of market area population growth did not deviate dramatically from the assumed 1 percent per year as shown in Appendix Table F-4.

A comparison of changes in participation rates from SCORP plans of states bordering the Mississippi River indicates MRI's growth rates are conservative. The growth factor for canoeing was developed from market area SCORP data.

The most current state participation rates for the river-related activities of boating, fishing, swimming, water skiing, and canoeing by SCORP region are shown in Appendix Table F-5. Whenever possible, the rate for the "most" river-related activity was used. For example, in Missouri, participation data were available on lake swimming and pool swimming, but only a lake rate was applied to population projection, assuming a natural resource swimming rate would best reflect potential demand to be satisfied on the Mississippi River.

The most current regional participation rates (from SCORPs) were normalized to a 1970 base year, 1970 equals 100. The MRI demand growth factors were then applied by activity and resulted in per capita participation rates for the forecast years 1980, 1985, 1990, 1995, and 2000.<sup>1/</sup> These rates are shown in Appendix Table F-6.

For each SCORP region 1980 participation rates for boating, fishing, swimming, water skiing, and canoeing were multiplied by the 1980 population projection to arrive at projected recreation days of use by activity. Appendix Table F-7 shows projected

<sup>1/</sup> MRI chose to develop a single growth rate and apply it to all SCORP base year participation data for two reasons: (1) Growth data were not available for all SCORP regions (e.g., several regions in Minnesota) and (2) SCORP studies were not conducted during the same years. In most cases state growth trends are based on extrapolation from only several data points; participation data for some years may be exaggerated, thereby making trends inaccurate.

recreation days by SCORP region and zone by activity for the years 1980, 1985, 1990, 1995, and 2000. The use of the forecasts will be discussed in Section 4d.

b. Forecast Comparisons: Regional data forecasts by MRI were compared with state projections from Missouri and Illinois in Tables 31 and 32, to evaluate the validity of MRI's forecasts and obtain some perspective of their potential use.

Table 31 suggests forecasts by MRI and the State of Missouri for recreation days of boating were similar in all regions except Region 11. The state forecast expects a much greater demand for recreation boating being generated in Region 11 than does MRI. Likewise, the state anticipates a much higher demand for fishing in all regions. Lake swimming demand projections are very close for both sources.

Growth demand factors generated by MRI show water skiing increasing 305 percent over base year 1970 figures. This growth seems to be ahead of state projections for all SCORP regions in the study area. Forecasts for canoeing demand are closer in Region 11 (St. Louis area) than in the rural Regions 4, 5, and 10, where MRI shows a more rapid growth rate.

Recreation demand forecasts for Illinois are shown in Table 32. All MRI forecasts for Illinois Regions 1A, 1B, 3A, and 4 are considerably higher. The demand growth factors incorporated into MRI's projections account for more influences than just change in population.

4. Zone Forecasts: Three separate techniques were utilized to forecast recreation use in the six zones along the Upper Mississippi River. These forecasts are explained below:

a. MRI SCORP Forecast: Utilizing the methodology described in the previous section, MRI prepared a forecast for each of the six zones. Figure 6 shows the amount of aggregate activity days of boating, fishing, swimming, water skiing, and canoeing for the five forecast years. These data are taken directly from Appendix Table F-7. As can be noted, five of the zones are projected to have similar increases in aggregate activity days (the slopes of the curves are almost identical). Zone 1, however, is projected to increase rather rapidly during the next 20 years. This zone is forecast to have the highest aggregate activity days, reaching 320 million by the year 2000. Zone 5 is forecast to have the smallest increase. Zones 2, 3, 4 and 6 are expected to grow at a similar rate, with these zones reaching between 50 and 70 million activity days for the five activities by the year 2000.

TABLE 31

MISSOURI DEMAND FOR RECREATION ACTIVITIES  
A COMPARISON OF MISSOURI SCORP AND MRI PROJECTIONS

	1980		1985		1990	
	SCORP	MRI	SCORP	MRI	SCORP	MRI
<u>Region 4</u>						
Boating	213,699	216,900	253,182	264,600	290,414	314,900
Fishing	854,373	721,100	1,012,200	780,700	1,161,046	841,000
Swimming	344,985	388,400	408,731	474,300	468,827	563,500
Water skiing	101,455	132,900	120,205	173,900	137,880	217,000
Canoeing	229,640	209,200	272,056	273,900	312,075	341,800
<u>Region 5</u>						
Boating	732,484	707,700	877,204	860,100	1,010,358	1,022,200
Fishing	1,681,224	1,372,900	2,013,386	1,479,300	2,319,005	1,593,400
Swimming	1,062,902	1,180,600	1,272,931	1,434,300	1,466,145	1,705,300
Water skiing	132,242	144,200	158,373	187,900	182,412	235,600
Canoeing	390,954	429,300	468,197	560,400	539,266	699,700
<u>Region 10</u>						
Boating	206,463	194,400	262,847	263,800	339,634	343,800
Fishing	296,266	232,600	377,184	280,200	487,365	330,400
Swimming	169,503	160,800	215,793	218,300	278,833	283,900
Water skiing	59,020	63,600	75,137	92,600	97,088	126,600
Canoeing	23,570	26,200	30,007	38,100	38,773	52,600
<u>Region 11</u>						
Boating	5,182,972	4,232,300	6,526,400	5,070,300	7,772,465	5,935,000
Fishing	12,214,414	8,608,400	15,380,393	9,165,600	18,316,922	9,720,800
Swimming	8,627,007	8,288,900	10,863,136	9,945,600	12,937,188	11,655,100
Water skiing	1,127,616	1,309,600	1,419,896	1,673,900	1,690,990	2,066,500
Canoeing	1,767,850	1,788,800	2,226,078	2,307,600	2,651,095	2,843,500

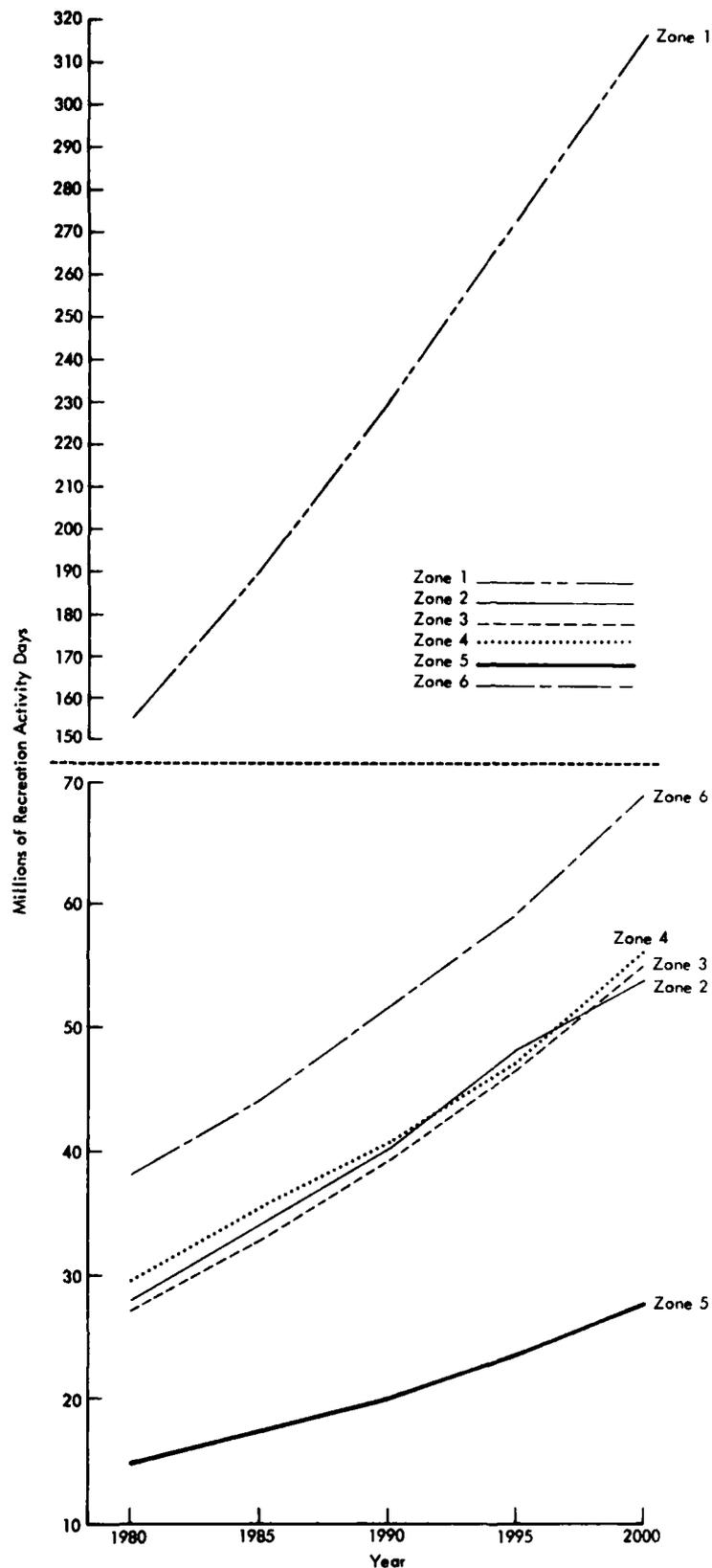
Source: 1973 Missouri Demand Update.

TABLE 32

ILLINOIS DEMAND FOR RECREATION ACTIVITIES  
A COMPARISON OF ILLINOIS SCORP AND MRI PROJECTIONS

Region	1980		1985		1990		1995	
	SCORP	MRI	SCORP	MRI	SCORP	MRI	SCORP	MRI
<u>Region 1A</u>								
Boating	2,779,922	3242,700	2,957,114	4057,400	3,361,204	4997,300	4,106,921	6077,000
Swimming	3,060,200	3568,700	3,255,257	4470,500	3,700,088	5497,000	4,520,989	6690,000
Canoeing	1,173,355	1475,500	1,248,144	1986,200	1,418,703	2563,600	1,733,457	3237,300
<u>Region 1B</u>								
Boating	3,105,907	2710,800	3,315,835	4537,500	3,680,344	5431,700	4,291,870	6446,800
Swimming	3,639,053	4347,200	3,885,017	5309,000	4,312,096	6349,300	5,028,594	7541,600
Canoeing	979,334	1253,200	1,045,572	1634,300	1,160,462	2056,700	1,353,284	2532,300
<u>Region 3A</u>								
Boating	1,389,945	1560,800	1,402,871	1882,300	1,482,484	2267,300	1,625,158	2661,700
Swimming	1,800,879	2018,900	1,817,628	2438,800	1,920,778	2941,200	2,105,634	3456,000
Canoeing	787,567	948,200	794,892	1233,100	840,002	1559,100	920,833	1897,000
<u>Region 4</u>								
Boating	3,766,018	4402,400	3,845,971	5194,500	4,111,651	6280,100	4,612,943	7463,300
Swimming	3,554,342	4148,000	3,629,801	4894,000	3,880,547	5916,700	4,353,664	7031,100
Canoeing	483,587	613,100	493,853	771,000	527,969	980,400	592,339	1210,300

Source: 1976 Illinois SCORP, June 1977 draft.



Source: MRI (Appendix Table F-7) Recreation Activities Include: Boating, Fishing, Swimming, Water Skiing and Canoeing

Figure 6 - Forecast of Recreation Activity Days By Use Zone Along the Upper Mississippi River

b. Relationship Between RRMS Trends and MRI SCORP

Forecasts: Since the MRI SCORP forecasts provide estimates of growth in recreation activities throughout the entire zone rather than just along the Mississippi River, MRI attempted two additional analyses to establish an estimate of future use along the river itself. The first technique involved establishing a relationship between zonal activity and recreation use of the pools. After this relationship was established, it was assumed to continue in the future with appropriate coefficients applied to the MRI SCORP zonal activity forecasts to project future use of the pools.

Specifically, the MRI SCORP zone forecasts were extended backwards to year 1977, and a ratio of the RRMS zone use to the MRI SCORP zonal activity was established. This provided an estimate of RRMS aggregate zone use, as a percent of the SCORP zone recreation activity or:

$$\frac{\text{RRMS (aggregate zone use)}}{\text{MRI SCORP zone activity}} \times 100 = \text{percent}$$

This relationship was assumed to remain constant until 2000 and thus the factors (see Figure 6 and Appendix Table F-7) were multiplied by the MRI SCORP zone forecasts. The resulting forecasts are presented in Figure 7. This figure essentially provides a forecast of recreation use of pools for each zone along the Upper Mississippi River. It is based on the 1977 relationship between aggregate RRMS zone visitation and SCORP zone recreation activity.

Figure 7 presents a somewhat different picture than the forecast of SCORP zone activity. Again, five of the zones have similar rates of growth, with Zone 4 showing the highest rate of growth (nearly doubling by the year 2000). Again this curve essentially projects the aggregate recreation use of the pools in each of the zones for the five forecast years.

c. Similar Project Forecasts: As a final methodology to forecast use of pools in each of the zones, MRI modified the Corps "similar project concept," utilizing per capita use rates from the GREAT Recreation Demand Analysis, June 1976.<sup>1/</sup> First the per capita use rates for the 13 pools under the jurisdiction of the St. Paul District were analyzed and classified into three types of pools (urban river pools, rural river pools and lakes). The basis for this

<sup>1/</sup> Brown, Richard E., et al., "Estimating Initial Reservoir Recreation Use," Plan Formulation and Evaluation Studies-- Recreation, Volume 2, June 1974, Insititute for Water Resources (Army), Fort Belvoir, Virginia.

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METHODOLOGY AND FORECASTS OF RECREATION USE AND SMALL  
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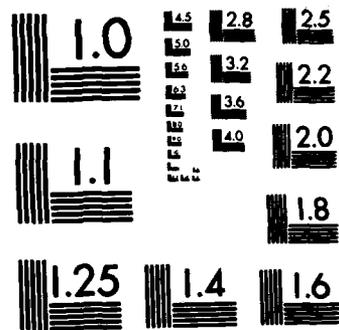
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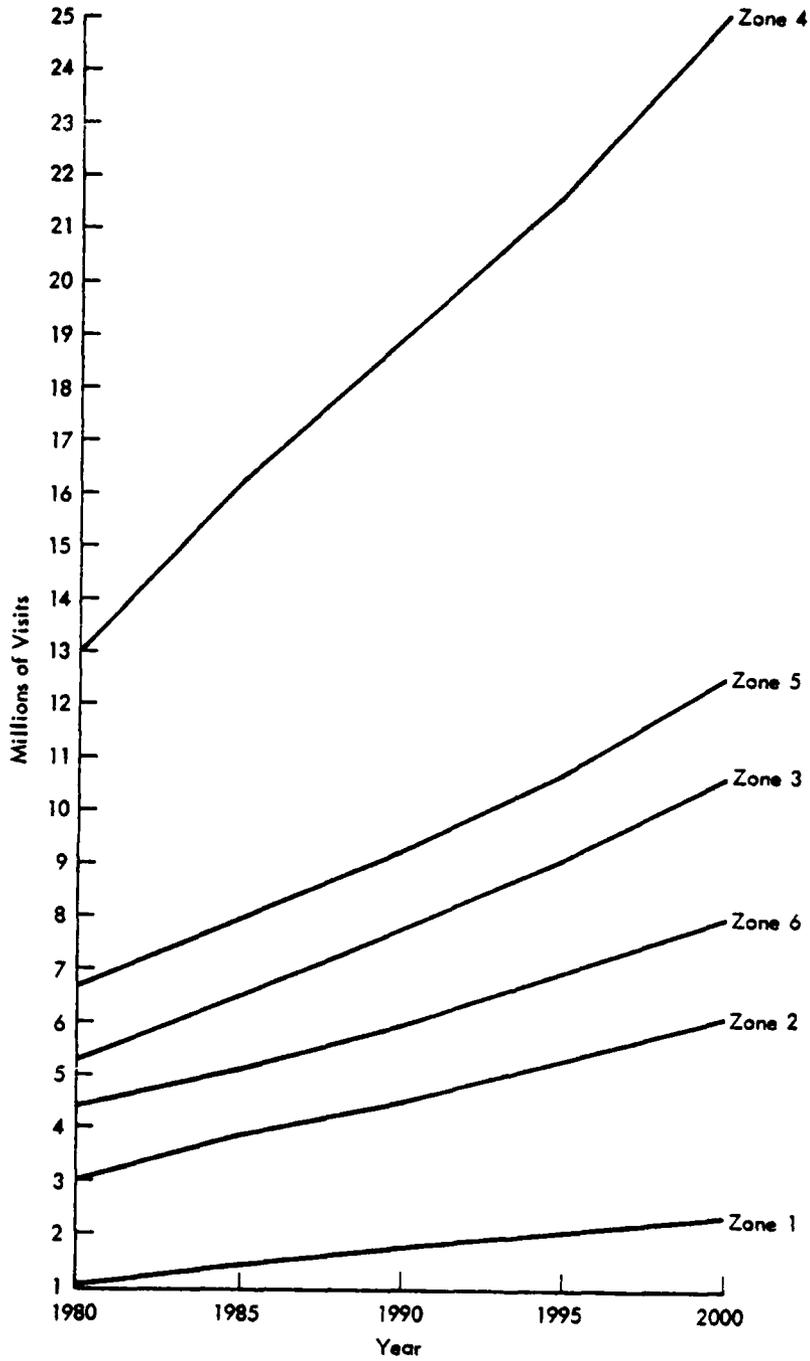
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



Source: MRI (RRMS Aggregate Zone Use as a Percent of SCORP Zone Participation Activity)

Figure 7 - Forecast of Recreation Use of Upper Mississippi River by River Use Zones

classification was primarily the resources in the pool and the type of per capita use rates generated at the 13 pools. Further classification would have resulted in little distinction between the classes because the per capita use rates varied little. Four pools were classified as urban river pools (including the Upper and Lower St. Anthony Falls, Pool 1 and Pool 2). Seven pools were classified as rural river pools (Pools 3, 5, 5A, 6, 7, 8, and 10). The lake classification included two pools, 4 and 9. The associated recreation activity per capita rates are shown in Table 33.

These rates were assumed to be characteristic of all pools along the Upper Mississippi River. After discussion with the St. Paul District, it was concluded that Pools 11 through 26 would all fall into the rural river classification. Thus, the appropriate per capita rates were utilized for these pools.

Using the same primary market area already identified in another part of this report and the distance matrix (between origin and destination area) from the gravity model, the population for the three zones for 5 forecast years and each of the 28 pools were calculated by computer techniques (see computer outputs in Appendix G). The next step was to apply the appropriate activity per capita use rates to each of the population zones for the 5 forecast years to forecast total recreation activity in the seven activities for the 28 pools. An internal computer subroutine provided for growth in the activity participation rates for each of the forecast years. These growth data were taken directly from MRI's COMPATRAX recreation participation allocation model. The total activity days at each pool were then converted to the number of visitor-days, using conversion factors developed from the GREAT I data. A final computer calculation provided an estimate of visitation from beyond the 75-mile zone. This factor was also developed from the GREAT demand study.

The conversion and expansion factors for each of the pool classifications are listed below:

	<u>Conversion Factor</u> (Activity Days to Visitor Days)	<u>Expansion Factor</u> (Include Visitation from Beyond 75 Miles)
River, Urban	0.963	1.166
Lake	0.494	1.360
River, Rural	0.581	1.322
Average	0.662	1.289

TABLE 33

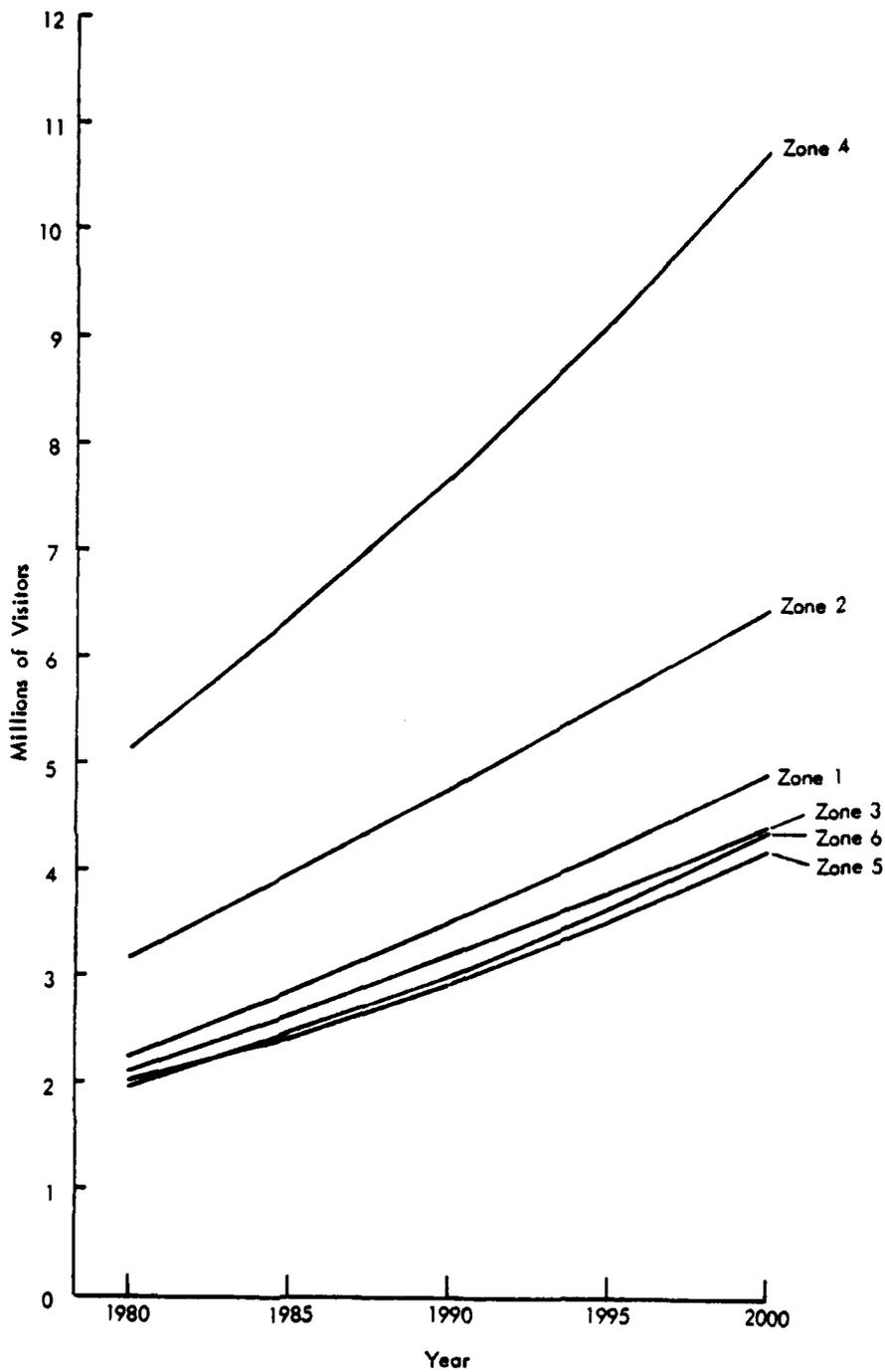
SIMILAR PROJECT PER CAPITA USE RATES  
(Base Year-1975)

	<u>Recreation Activities</u>						
	<u>Picnic</u>	<u>Camp</u>	<u>Swim</u>	<u>Wt. Ski</u>	<u>Boating</u>	<u>Sightsee</u>	<u>Fishing</u>
<u>River, Urban</u>							
Zone							
I	0.008	0.005	0.001	0.007	0.0068	0.003	0.016
II	0.004	0.001	0.001	0.002	0.030	0.051	0.012
III	---	---	---	---	---	---	---
<u>Lake</u>							
Zone							
I	0.897	1.008	1.266	2.833	7.193	1.663	4.525
II	0.060	0.245	0.114	0.130	0.192	0.077	0.323
III	0.024	0.026	0.028	0.008	0.141	0.035	0.125
<u>River Rural</u>							
Zone							
I	0.200	0.189	0.166	0.298	1.109	0.413	1.079
II	0.047	0.060	0.044	0.094	0.271	0.097	0.303
III	0.027	0.022	0.024	0.032	0.107	0.046	0.127

The final step was to aggregate the pool visitation into the six zones. These forecast data were then graphed and are shown in Figure 8. As with the previous forecast technique, Zone 4 shows the highest rate of growth, doubling by the year 2000. The level of use, however, is less than half that of the previous forecast. In addition, the 1980 estimate is only about 40 percent of what was reported by the RRMS in 1978. Zone 2 shows the next highest level of use with the remaining four zones nearly the same.

d. Conclusions Regarding Recreation Use: There is a large difference in both the level of recreation use forecasts and the ranking of the zones using the techniques described above. The one main similarity is that Zone 4, which includes the Quadcities, appears to have the highest potential for growth along the Upper Mississippi River. This is primarily the result of a large concentration of population adjacent to the Mississippi River and few recreation resource alternatives.

MRI is presently involved in a study for the Waterways Experiment Station (WES). WES has been assigned the function of developing and coordinating recreation research programs throughout the Corps of Engineers. A major thrust of their program will be to improve recreation visitation estimates and forecasts. During the next few years, the St. Paul District can expect a number of changes in the methodology, and no doubt the visitation forecasts presented in this report will undergo revision. Additional study of this area is recommended in the next Chapter of this report.



Source: MRI (Modified similar project technique--see Volume II, Appendix G)

Figure 8 - Forecast of Recreation Use of Upper Mississippi River by River Use Zones

## CHAPTER VII

### RECOMMENDATIONS FOR FUTURE RESEARCH

Throughout this study the basic problem has been one of lack of data. In subsequent years, no doubt the Corps of Engineers will undertake studies to establish the quality of pools and the demand for various types of recreation activities. For example, the Waterways Experiment Station has initiated a project to improve the Recreation Resources Management System. As more accurate visitation estimates become available, these and other appropriate variables should be tested by regression or other statistical analysis to determine their impact on recreation lockage. Specific recommendations regarding future research are discussed below:

#### A. Determine the Long-Term Forecasting Power of the Lockage Forecasting Model

During the course of the study, the regression analysis was conducted on both 1976 and 1977 data. A new source of information for 1977 was the updated GREAT Recreation Facility Inventory. The 1977 commercial lockage data were also utilized in the updated analyses. Although there were slight differences in the degree of correlation and the ordering of variables in the step-wise regression, the overall results were similar.

Since the recommended lockage model applies only to 1976 and 1977, it is suggested that the analysis be tested for 1978 and subsequent years. As other data become available such as updated Marina slip inventories, commercial lockage, long-distance flow factors, and other measures such as quality, these variables should be introduced into the model to determine their potential in forecasting recreation lockage. Only in this manner will the St. Paul District be guaranteed of developing a recreation forecasting model that has long-term value.

#### B. Continued Monitoring of Lockage Traffic

Although the recreation lockage survey (summer 1977) provides much-needed recreation data, it provides basic characteristics of users for only one point in time. Furthermore, the statistics do not necessarily describe the characteristics of lockage users during the spring and fall seasons. Boater characteristics result from numerous variables which change over time. There is a need, therefore, to document the characteristics for all seasons and for selected future years.

To our knowledge, this was the first attempt by the Corps of Engineers to obtain more than the very limited statistics required by the PMS system. No doubt this system will undergo evolutionary change, requiring additional statistics to be collected and analyzed.

It is recommended, therefore, that a similar type of survey to the one conducted in the summer of 1977 be conducted for all seasons, and at a minimum of every 5 years (see Questionnaire in Appendix A, Volume II). Extreme care should be utilized in any modification of the questionnaire so that the survey results in future years will be comparable to this baseline study. Obviously, cost is an important factor in collecting data. An alternative approach would be a postcard type survey of selected questions that could be distributed by Corps personnel or university students (under contract) at all lock and dams. The cost of the mailback survey would only be slightly more than the printing and mail costs involved.

Several specific questions might be asked if a mailback survey is undertaken. These are listed below:

- What is your place of residence?
- Where did you put your boat in the river?
- What is the destination of this boat trip?
- On this entire trip, how many locks will you lock through?

The number of locks used by boaters in the survey formed a basic part of the regression analysis. As a result, the lockage forecasting methodology is based on a single point in time. To provide validity over the years, this factor must be updated. The other questions could enable Corps planners to identify major shifts or patterns in recreation lockage. The mail survey could provide this important component to the forecasting methodology.

To verify results, a major survey could be conducted every 5 years to see if there is a significant difference between mailback and on-site surveys. The full-scale survey could include all questions asked in the 1977 survey, plus others that are required in the future.

### C. Documentation of Recreation Use and Future Methodologies

Perhaps the weakest area of the study was in terms of the factors affecting recreation activity on pools of the Upper Mississippi. To improve this element of the recreation lockage model, the following recommendations are provided:

#### 1. Documentation of Recreation Activity on the Pools:

A major conclusion of the study, was that recreation lockage is related to a surrogate of boating activity on the pools. Because recreation use is not well documented, a surrogate rather than a direct measure of the activity had to be utilized in the forecasting model. In the future it is recommended that attention be focused on better measures of recreation use, particularly water-related activities such as boating and water skiing.

A part of the problem relates to the relative newness of the Recreation Resources Management System (RRMS) and the difficulty in measuring dispersed use. MRI is presently involved in a study for the Waterways Experiment Station to recommend improvements in the RRMS and suggest techniques to more accurately measure recreation use. As the system improves and is cross-checked with aerial surveys such as the one conducted by GREAT I during 1976 and the GREAT II recreation use studies of 1978 it is recommended that the Corps utilize the forecasting model proposed in this report and evaluate its effectiveness by incorporating more direct measures of boating use. Since recreation planning and demand forecasting are still in their infancy, it is anticipated that the forecasting model will undergo considerable change during the next 10 to 20 years.

#### 2. Methodologies for Projecting Recreation Activity:

Assuming that future studies show a correlation between boating activity and recreation lockage, it is recommended that the St. Paul District explore demand forecasting techniques that utilize a systems approach to recreation use forecasting. MRI has pioneered in the development of a systems model which may hold a part of the answer to this problem. Called COMPATRAX, the MRI model forecasts activity participation originating in demand centers and allocates this use into various resource attractions. Unfortunately, the present study was not oriented to using this model. (Neither time nor sufficient funding was available for the necessary modifications of the model.) At some future date, the Corps of Engineers may consider use of the COMPATRAX or a similar type of model to forecast boating use. The outputs of such a model could be interfaced with the lockage forecasting model.

### 3. Population Surveys of Perceptions About Recreation

Lockage: Unfortunately, data are presently not available to examine some of the more basic questions regarding boaters' perceptions of lockage and how it affects recreation use. It is recommended, therefore, that further study be made in this area. Since a list of registered boaters has been assembled as part of another study sponsored by the St. Paul District, a mail-back survey of registered boaters may be considered to determine perceptions about lockage and what effect it has on use. Then questions about the promotion of facilities and how it might affect lockage may be answerable.

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