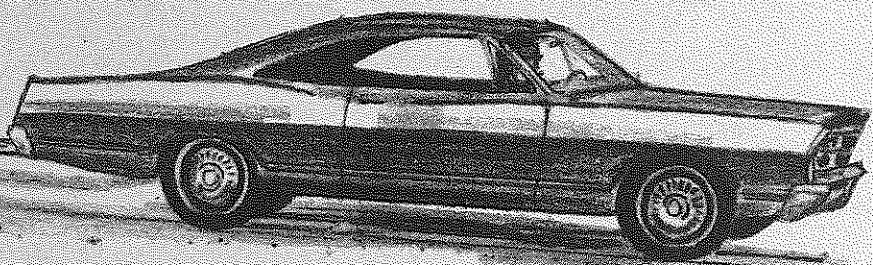


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MICHIGAN MARINE GAS TAX STUDY

JOINTLY PREPARED BY MICHIGAN DEPARTMENT
OF NATURAL RESOURCES
MICHIGAN DEPARTMENT
OF STATE HIGHWAYS

WITH COOPERATION OF UNITED STATES DEPARTMENT
OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

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MICHIGAN MARINE GAS TAX STUDY

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Jointly Prepared By:

Michigan Department of
Natural Resources

Michigan Department of
State Highways

With Cooperation Of:

United States Department
of Transportation

Federal Highway Administration

November, 1971

MICHIGAN DEPARTMENTS OF
NATURAL RESOURCES AND STATE HIGHWAYS
COOPERATIVE STUDY GROUP

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Gentlemen:

The Michigan Marine Gas Tax Study was undertaken as a joint effort of our two agencies. It was initiated during the summer of 1969 to find the best means of determining how much gasoline was purchased in Michigan for use in recreational boating. The purpose was to provide a basis for determining the percentage of the Michigan Motor Vehicle Highway Fund that should be made available to the Waterways Commission.

The members of the Joint Study Group present this study to you as the most accurate estimate obtainable of gasoline purchased in Michigan for recreational boating purposes. It is intended that copies also will be distributed to pertinent committees of the Michigan Legislature.

Sincerely,



Keith Wilson, Director
Waterways Division
Department of Natural Resources
(Study Co-Chairman)



Sam F. Cryderman
Engineer of Transportation Planning
Transportation Planning Division
Department of State Highways
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TABLE OF CONTENTS

	<u>Page</u>
Study Summary	1
Procedures	3
Findings	5
Discussion	6
Segment 1, Survey of Privately Used Boats Registered to Michigan Owners . .	9
Procedures	10
Findings	10
Discussion	14
Segment 2, Survey of Out-of-State Boats Leaving Michigan via Highways . . .	17
Procedures	17
Findings	23
Discussion	24
Segment 3, Survey of Out-of-State Boats Entering Michigan via the Waterways	25
Procedures	26
Findings	32
Discussion	33
Segment 4, Survey of Rental Boats Registered in Michigan	39
Procedures	40
Findings	43
Discussion	46
Segment 5, Survey of Documented Boats Purchasing Fuel in Michigan	49
Procedures	49
Findings	51
Appendix A (Segment 1)	A-1
Appendix B (Segment 2)	B-1
Appendix C (Segment 3)	C-1
Appendix D (Segment 4)	D-1
Appendix E (Segment 5)	E-1

MICHIGAN MARINE GAS TAX STUDY

Study Summary

In Michigan all receipts from the sale of motor-fuel taxes are deposited in the Motor Vehicle Highway Fund. From this fund, certain amounts are dedicated for specific purposes, annual appropriations are made for collection and administration, and the remainder is used for highway purposes as defined by law. Among the dedicated amounts is the legislated requirement that $1\frac{1}{2}$ percent of the total collected be transferred to the State Waterways Commission for development of recreational boating facilities.

Prior to 1968, the dedicated portion for the State Waterways Commission was maintained at one-half of one percent, an amount which merely represented recognition that some portion of the total gasoline tax revenue was supplied from boating use. Based largely on known increases in boating activity in Michigan, and a desire for expansion of related state programs, the legislature increased the dedicated amount to its present $1\frac{1}{2}$ percent level.

A basic tenet of dedicated revenue is that the amount received should be utilized for programs related to the generating source. Although this appears to be the basis for the $1\frac{1}{2}$ percent "ear-marked" for the State Waterways Commission, there has previously been no factual study of the amount of tax generated by boating use. Continuing increases in Michigan's

boat registration have led to a renewed interest in this question. In order to establish a factual basis for determining the appropriate amount of fuel tax revenues to be allocated to the Waterways Commission, the Department of State Highways and the Department of Natural Resources conducted this study of marine fuel consumption in Michigan.

The purpose of this study is to estimate the percentage of gasoline sold in Michigan for use in recreational boating activities. All vessels referred to in this study are recreational in function; commercial vessels do not benefit from the dedicated fuel tax revenues and are not considered part of the generating source.

The study was conducted according to the recommendations of the Michigan Marine Gas Tax Study Proposal, prepared in the summer of 1969 by an Inter-agency Study Group of the Department of Natural Resources and the Department of State Highways. These two departments are also responsible for the contents of this final study.

After a review of similar state studies, consideration of relevant boating data available for the study, and certain time constraints, the Inter-agency Study Group determined that the most reliable and objective approach to the subject would be to analyze fuel consumption estimates supplied by a large sample of boat owners. To obtain the necessary data, a survey of Michigan

boaters was conducted. The total marine fuel consumption for Michigan was established and its percentage of the state's total gasoline consumption computed.

The remainder of this section summarizes the research procedures and the essential findings of the study. The following section contains the reports on the basic surveys conducted to obtain the study data. The final section consists of appendices of more detailed research data, copies of survey instruments, explanations of peripheral issues, and statistical analysis.

Procedures

The review of available information on characteristics of the Michigan boating population indicated that five (5) separate analyses were necessary to obtain the desired information. The study was then segmented into the following categories:

1. Boats registered in Michigan;
2. Out-of-state boats leaving Michigan via the highways;
3. Out-of-state boats entering Michigan via the waterways;
4. Rental boats; and
5. Documented boats (larger boats voluntarily registered with the the Coast Guard in lieu of state registration).

The reason for this segmentation was to facilitate the analysis of the possible effects of different types of boat usage on fuel consumption rates. In the remainder of this report, these segments are detailed individually

since each one was directed at different specifics and there was little uniformity in the special surveys used.

The largest survey, that of privately-owned boats registered to Michigan owners, was conducted by mail, as were the rental and the documented boat surveys. Out-of-state boats leaving Michigan via the highways were sampled through interviews with the out-of-state boat owners in a screen-line highway survey. The fuel consumption of out-of-state boats entering Michigan via the waterways was estimated by a sample survey of fuel sales to out-of-state boats at marinas at appropriate lakeshore locations.

Mention should be made at this point of the minor problem of fuel consumption by unregistered boats. There appears to be no feasible means of obtaining data concerning the number or use of these boats. On the assumption that they are generally small boats and that their use is illegal, it was decided that they do not represent a significant part of the consumer groups. Because of these factors, it was felt that further analysis of the question was not justified and no allowance for this type of consumption was made in any of the surveys.

In 1970, there were 4,603,589,992 gallons of fuel sold in Michigan. However, not all of that gallonage is within the scope of this study. The following items must be excluded from the total gallonage:

1. Jet Fuel - 230,002,509 gallons
2. Diesel Fuel - 187,636,349 gallons
3. Liquid Propane Gas - 1,962,245 gallons
4. Shrinkage Allowance - 121,315,426 gallons
5. Aviation - 15,953,625 gallons
6. Refunded for non-highway use - 99,484,538 gallons
7. Exempted sales - 163,238,915 gallons.

Therefore, the net gallons of gasoline taxed for highway use in Michigan during 1970 under the 1968 Motor Fuel Tax Laws was 3,783,996,385 gallons.

Findings

From each segment of the study, an estimate of the gallons of gasoline used by boats in Michigan pertinent to that segment was obtained. These estimates are as follows:

1. Michigan Registered Boats - 25,319,857 gallons
2. Out-of-State Boats via Highways - 497,341 gallons
3. Out-of-State Boats via Waterways - 858,954 gallons
4. Rental Boats (Liveries) - 356,214 gallons
5. Documented Boats - 625,774 gallons

Hence the total gallonage for all segments is estimated to be 27,658,140 gallons, or 0.73% of the 3,783,996,385 gallons of net taxed gasoline.

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Discussion

While great care was taken in the formulation and execution of the study, certain limitations resulting largely from timing necessities should be noted in any interpretation of the results. First, there is some question as to how typical a year was selected for the study in terms of the amount of boating done and therefore the gas consumed. Although the absolute effect of this factor is not known, several circumstances existed which may have caused 1970 to have been atypically low in total boating activity. First was the fishing ban imposed on the lower Lake Huron-Lake St. Clair-Detroit River, Lake Erie area of the State. The dramatic effect on fishing is indicated, in part, by the 21.7% drop in annual resident license sales experienced in 1970 in the five counties bordering this area (St. Clair, Wayne, Sanilac, Macomb and Monroe). The general trend in license sales in previous years was upward. Reports from area marinas indicate even greater reductions in boating activity. A Department of Natural Resources survey in 1967-68 estimated that over 2,000,000 days of fishing took place on Lake St. Clair during the 12-month study period. Another survey covering the 1970 calendar year indicated that the number of fishing days had decreased more than 80% from the earlier survey. Lake Erie sport fishing probably suffered a similar decline, but information on days of fishing prior to the discovery of high levels of mercury in sport fish is not available. The significance of the Lake St. Clair fishery is indicated by the fact that prior to 1970, Lake St. Clair accounted for more angler days than the three Upper Great Lakes combined.

Another reason 1970 may have been atypical involves the general economic conditions which prevailed in Michigan at that time. Unemployment was high and growing rather rapidly, inflation was growing and consumer demand falling. It is probable that these conditions had some negative effect on new boat purchases as well as on total use by existing boat owners. Confirmation of both these factors must, of course, await further study.

The finding that an excessively high concentration of DDT was present in the tissues of fish taken from Lake Michigan is also believed to have had some negative effect on Great Lakes boating in general and especially on out-of-state visitation. Since the introduction of Coho salmon, a significant sport fishery has developed which depends upon boating for access to the fish. Therefore, any deleterious effects on the fish will obviously affect boating in no small way.

The net affect of these circumstances is not known precisely. However, the pretest for the registered boat survey estimated that some 28,631,625 gallons of gasoline were used for boating in 1969 or about 3.3 million gallons more than the registered boat consumption estimated for 1970.

A more important limitation resulted from selection of the sample for the survey in Segment 1 at the midpoint of the three-year registration cycle and resulted in a potentially sizeable loss in the universe of boats used in expanding the sample data. In 1970 when the sample of Michigan boat owners was drawn, a data tape was requested from the Secretary of State giving the most current registration listing. This tape included some 365,929 registered craft (351,367 private boats and 14,562 rental craft). The preceding three-year registration period showed a total of 438,017 registered craft. This would indicate a net decline of 72,088 craft from 1968 to 1970.

A review of previous three-year registration cycles indicates an average increase of 3.3% per year. If that average was maintained in the three-year cycle beginning January 1, 1969, the boat population by December 31, 1970, should have increased by 28,910 boats making the total registered fleet as of that date 466,927.

If this universe in fact existed, it means that some 86,436 boats (the 100,998 boat difference between 1969 and predicted 1970 registrations less the 14,562 rental craft) were not included in the fuel consumption figures. These craft would have consumed 6,228,665 gallons of gasoline, assuming the same mean annual consumption of fuel per boat (86,436 boats x 72.061 gal/boat). This would increase the estimate of the percentage of gasoline used for boating to about 0.83 percent of the total gasoline taxed.

If fact, an error of this nature could very easily occur, judging by past experience with boat registration cycles. A three-year registration cycle has been in effect in Michigan since 1959, with the first cycle ending December 31, 1962. Subsequent registration cycles have ended on December 31, 1965 and 1968. In every instance, boat registrations for the following one- and two-year periods have been less than the previous three-year closing total. It is generally assumed that this is caused by the fact the registration expires in winter when the boat is in storage and that it is subsequently renewed only when the boat owner remembers or is reminded by law enforcement action. Regardless of the reason for this phenomena, its existence makes determination of the actual registered fleet of recreational watercraft, at any time other than the end of the three-year cycle, most difficult.

Segment I Survey of Privately Used Boats
Registered to Michigan Owners

Prepared and Conducted by the
Transportation Planning Division,
Department of State Highways

The purpose of this segment of the study is to estimate the amount of gasoline sold to privately used boats registered to Michigan owners. To obtain this information, a mail survey was conducted of a sample of boat owners from the Michigan boat register. All supplementary material for this segment is contained in Appendix A in Section III of this study.

As will be explained in Segment 4, the file of Michigan registered boats was separated into those classified as "owner-user" and those "for rent" on the basis of hypothesized differences in user characteristics. The assumption was made that a single ownership of five or more boats indicated they were for rent and were thus classified as "boat liveries," to be accorded special analysis.

In Michigan, boats are registered for a given three-year period; at the end of the period, all registrations expire and must be renewed if the owner wishes to use his boat. On January 1, 1970, all previous registrations expired. Therefore, the universe for this and the livery segments was composed entirely of current registrations. After deletion of "livery" boats, the size of the universe for this segment was 351,367 registrations.

Procedures:

Since there are only a few marine fuel studies available for comparison, it was not possible to estimate the probable variance for a survey of this type and, therefore, there is no recommended minimum sample size. It was decided to take a sample of 60,000, or approximately 20% of the survey universe. Response to a Pre-Study mail survey indicated that about 50% of the mail questionnaires would provide usable returns. This indicated that the 60,000 sample size would provide a usable sample of 10% of the survey universe. The sample was allocated to fifteen propulsion-length categories with an optimum allocation (the so-called Neyman allocation), sample size for a category being proportional to the product of the size of the category and the (sample) standard deviation of the category as derived from the survey Pre-Study. ^{1/}

A mail questionnaire was devised and sent to the sample names drawn from the boat register. ^{2/} Although two follow-up (reminder) mailings were originally envisioned, only one was determined to be essential. Even with the single reminder, the rate of usable response was 60.41%.

Findings:

The survey results are presented below. The total number of gallons consumed is discussed and then detailed by propulsion-length class.

Estimates of total and mean consumption, variance and standard deviation of the estimators, and confidence intervals on the true mean and total:

^{1/} See Appendix A, Item 1.

^{2/} Ibid., Items 2 & 3 for copies of the questionnaire & accompanying letter.

Based on a usable sample of size 36,250 boats and a population size of 351,367 boats, the estimator of the true mean (i.e., average) number of gallons of gas consumed per boat is:

$$\bar{G} = 72.061 \text{ gallons}$$

The sample standard deviation of the estimate \bar{G} was calculated to be:

$$S_{\bar{G}} = 0.5662 \text{ gallons}$$

Therefore, a 95% confidence interval on the true mean consumption per boat is given by:

$$\begin{aligned} & [\bar{G} - 1.96S_{\bar{G}}, \bar{G} + 1.96S_{\bar{G}}] \\ & = [70.951, 73.171] \end{aligned}$$

Likewise, we can put a 95% upper confidence limit on the true mean, i.e., in 95% of the replications, we would expect the true mean to lie below such a limit. A 95% upper confidence limit is given by:

$$\bar{G} + 1.645S_{\bar{G}} \leq 72.992$$

In the case of the total number of gallons consumed, the data yields an estimate of:

$$G = 25,319,857.387 \text{ gallons}$$

and an estimate of its standard deviation of:

$$S_G = 198,943.995 \text{ gallons.}$$

This permits the construction of a 95% confidence interval on the true total gallons consumed of

$$\begin{aligned} & [G - 1.96s_G, G + 1.96s_G] \\ & = [24,929,840.017, 25,709,874.757] \end{aligned}$$

and a 95% upper confidence limit of

$$G + 1.645 s_G \leq 25,646,980.064 \text{ gallons.}$$

Detail of results by propulsion-length category:

For each propulsion-length category, the following generic terms are defined as:

N = number of boats in that category in the population.

n = number of boats in that category in the sample.

\bar{G} = estimator of the average number of gallons of gasoline consumed per boat in the category.

S = sample standard deviation of the estimator \bar{G} .

L = 95% upper confidence limit on the true mean.

PROPULSION

LENGTH	INBOARD	OUTBOARD	SAIL/AUXILIARY
0 - 11.99 ft.	$N = 684$ $n = 3$ $\bar{G} = 440.667$ $S = 435.689$ $L = 1556.031$	$N = 105,090$ $n = 516$ $\bar{G} = 19.469$ $S = 1.559$ $L = 23.460$	$N = 216$ $n = 6$ $\bar{G} = 111.667$ $S = 55.404$ $L = 253.501$
12 - 19.99 ft.	$N = 14,713$ $n = 2215$ $\bar{G} = 165.751$ $S = 4.690$ $L = 213.745$	$N = 207,522$ $n = 26,475$ $\bar{G} = 62.653$ $S = 0.597$ $L = 64.181$	$N = 1264$ $n = 17$ $\bar{G} = 7.618$ $S = 2.091$ $L = 12.971$
20 - 29.99 ft.	$N = 11,129$ $n = 3227$ $\bar{G} = 328.012$ $S = 8.312$ $L = 349.291$	$N = 5711$ $n = 1297$ $\bar{G} = 89.085$ $S = 4.137$ $L = 99.676$	$N = 1001$ $n = 84$ $\bar{G} = 46.281$ $S = 13.503$ $L = 80.849$
30 - 39.99 ft.	$N = 3083$ $n = 1981$ $\bar{G} = 823.262$ $S = 19.647$ $L = 873.558$	$N = 143$ $n = 21$ $\bar{G} = 139.667$ $S = 32.248$ $L = 222.222$	$N = 239$ $n = 14$ $\bar{G} = 83.779$ $S = 26.275$ $L = 151.043$
40 + ft.	$N = 494$ $n = 373$ $\bar{G} = 1426.354$ $S = 126.003$ $L = 1748.922$	$N = 16$ $n = 6$ $\bar{G} = 302.500$ $S = 187.267$ $L = 781.904$	$N = 42$ $n = 15$ $\bar{G} = 82.400$ $S = 22.216$ $L = 139.273$

Discussion:

Several other boating issues were explored through items on the survey questionnaire. On the basis of data obtained from the survey, it was estimated that 94.65 percent of the sampling universe still owned the boat they had registered at the time of the survey. Also, an estimated 94.89% used their boats in Michigan waters during the study period. This data lends credence to the assumption that the file of registrations is current.

To get at the question of intensity of use, boaters were asked to compare the number of gallons consumed during the study period with the identical period one year earlier. The most common answer was "about the same", with the distribution of responses showing little skew toward either "much higher" or "much lower".

It is interesting to note that, as nearly as could be determined, no consistent relationship exists between the average horsepower of motor used on a boat and that boat's annual gasoline consumption. In each propulsion-length category, the correlation co-efficient was computed between average horsepower and gasoline consumption, with mixed results. In most classes (See table below) the correlation co-efficient was less than 0.5.

Correlation between Gasoline Consumption
and Average Horsepower

	<u>Inboard</u>	<u>Outboard</u>	<u>Sail/Aux.</u>
0-11.99 ft.	0.58	0.50	- 0.37
12-19.99 ft.	0.19	0.43	0.44
20-29.99 ft.	0.08	0.49	0.14
30-39.99 ft.	0.23	0.66	0.49
40 + ft.	0.11	0.84	0.16

While a relationship may exist between the horsepower of a motor and its rate of gasoline consumption per hour of operation, there seems to be little correlation between horsepower and the total amount of gasoline used annually. As can be readily seen, in all but a few cases, it would be impossible to generate a survey model, linking horsepower and annual gasoline consumption, which has any predictive power.

Segment 2 Survey of Out-of-State Boats
Leaving Michigan via Highways

Prepared and Conducted by the
Transportation Planning Division
Department of State Highways

Michigan and its waterways are easily accessible from neighboring states. The survey in Segment 1 accounted only for the fuel consumption of boats registered in Michigan. Segment 2 of this study was undertaken to develop a statistical base for estimating the amount of gasoline purchased in Michigan for use in boats that had been transported into Michigan on the state highway system. Boats entering Michigan via the waterways will be considered in Segment 3.

This project was designed to collect data during the four months of June through September, 1970, at the state line. All supplementary material for this segment will be found in Appendix B in Section III of this study.

Procedures:

Thirty-Three major highway locations (hereafter referred to as stations) were selected as the major state line gateways and procedures were established to collect a sample of such boating use. The sample was selected from boats as they exited the state rather than as they entered it, since at this time the owners would be better able to estimate the amount of gas they had used. See figure 1 for the listing of the stations and their locations in the state.

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Survey Stations For Out-Of-State Boats Leaving Michigan Via The Highways

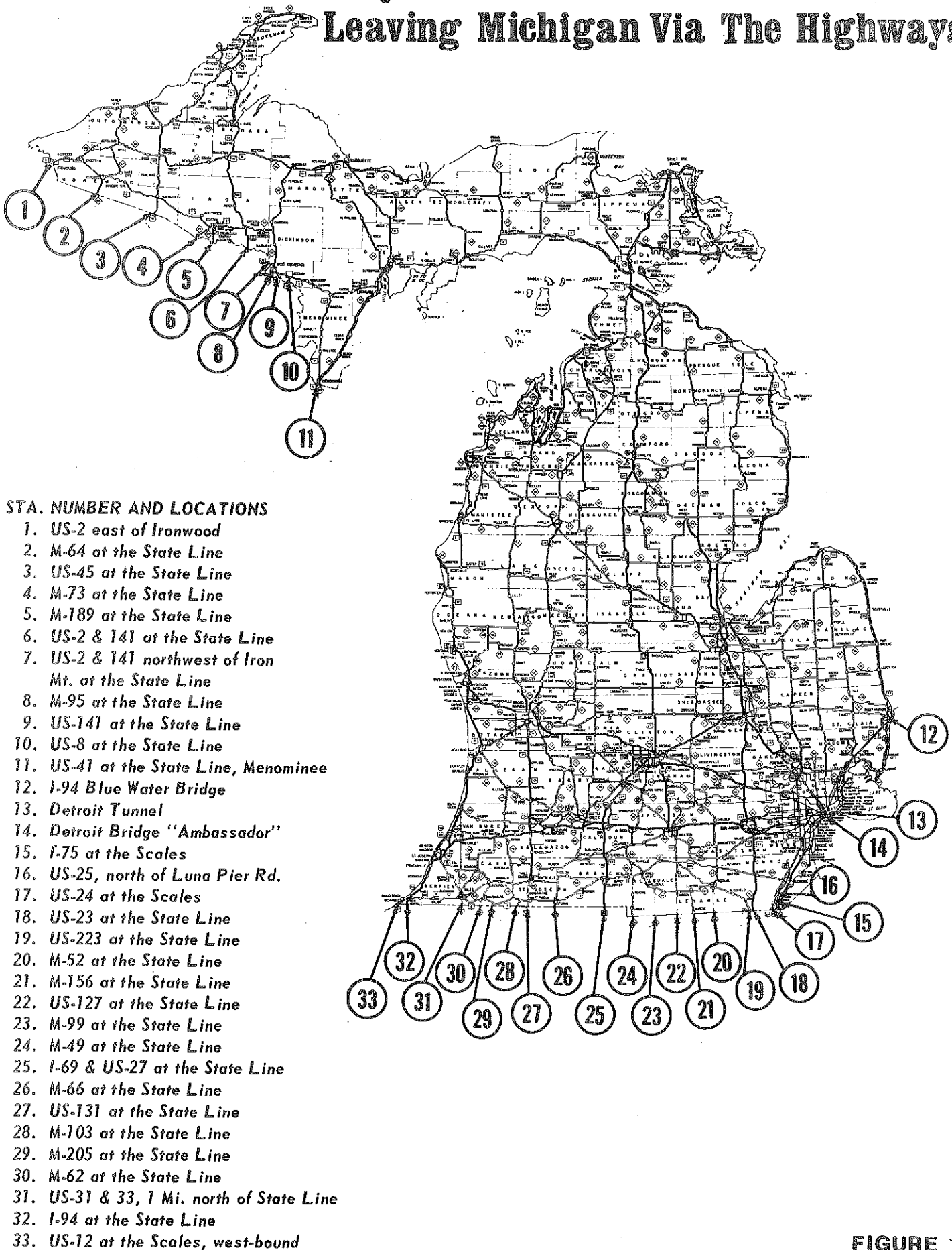


FIGURE 1

The data collected was of three types - machine count data of all vehicles exiting the state at one of the thirty-three stations, manual classification of traffic by type at each of the stations, and personal interviews of drivers of vehicles towing out-of-state boats.

The collected data was analyzed in the following manner: (1) From the interview data, an estimate of the ratio of gallons of gas to boats was calculated; (2) from the classification data, an estimate of the ratio of boats to traffic was determined; (3) the total traffic during the four month period was estimated, using generally accepted traffic expansion techniques based on the station machine counts; and (4) these three estimates were pooled to yield an estimate of the gallons of gas purchased in Michigan, during the four month period, for use in boats which had been transported into the state on the road network.

Machine Counts

At all thirty-three stations continuous machine counts were taken of traffic leaving the state during the four month study period.

The machines give an hourly axle count during the period when they are set in place. Theoretically the hour axle count at each station for each day of the four month study should have been available. However, the machines do fail occasionally for various mechanical reasons. To attempt to minimize

the out-of-service time, the machines were checked regularly and reset or repaired when a mechanical failure occurred. This precautionary procedure insured sufficient data to estimate the total traffic leaving the state at each station during the four month period.

Interviews

To insure a representative sample for each station, interviews of drivers of vehicles towing out-of-state boats were conducted at selected times.^{1/} An interview was conducted on one Saturday and one Sunday from 1:00 p.m. to 7:00 p.m. and on two weekdays from 7:00 a.m. to 1:00 p.m. and 1:00 p.m. to 7:00 p.m. So in all, there were six interview periods for each station.

The main concern during the interviews was determining the amount of gasoline purchased in Michigan by the user of the particular out-of-state boat. However, other information was obtained such as origin-destination data, size of boat, horsepower of boat motor, and length of stay in Michigan.

Classifications

For each station, manual classification counts of traffic by type were also taken at selected times. They included those taken at the same time and place of each interview, as well as those at supplemental times as described below. The technician making the manual classifications recorded an hourly total of traffic by type and the number of out-of-state boats observed.

^{1/} See Appendix B, Item 1 for times and dates of interviews.

Saturday and Sunday classification periods were broken into four periods - midnight to 7:00 a.m., 7:00 a.m. to 1:00 p.m., 1:00 p.m. to 7:00 p.m. and 7:00 p.m. to midnight. A classification was taken at each station for each of these time periods once on Sunday and once on Saturday during the four month study with the 1:00 p.m. to 7:00 p.m. period corresponding to the interview period described above.

Weekday classification periods were broken into six periods - midnight to 7:00 a.m., 7:00 a.m. to 11:00 a.m., 11:00 a.m. to 1:00 p.m., 1:00 p.m. to 3:00 p.m., 3:00 p.m. to 7:00 p.m., 7:00 p.m. to midnight. For each station, a classification was taken at each of these periods twice during the four month study. Additional classifications were conducted on other weekdays from 7:00 a.m. to 1:00 p.m. and from 1:00 p.m. to 7:00 p.m. twice to correspond with interviews taken on weekdays as described above. So in all, classifications were taken twenty-four times for each station of which six of these times coincided with interview periods.

As anticipated, a number of problems arose in the interview periods. At a few stations some vehicles with boats would not or could not be stopped due to bad weather, heavy traffic, or the driver's refusal to stop. In other cases the driver refused to cooperate and would not answer the questions. However, these instances were infrequent and are expected in this type of study.

Another problem was that some cars were towing two or more boats. In these instances, multiple boats hauled by one car were counted as one boat (whichever was determined to be the largest) and the classifications treated them the same as any other single boat.

Some interviews resulted in "no gasoline purchased or used." This reflected the fact that some boat owners passed entirely through the state and others bought their gas before entering. Such responses are included because of their importance to the statistical analysis.

Data Analysis

In analyzing the data from the machine counts of traffic taken during the four month study, an average count was calculated for each station from the available data for that station. Then the average count was tabulated for the total thirty-three stations by simply averaging the average count from each station. ^{2/} Next a ratio of actual traffic to machine counts was calculated using the data collected at the classification periods and the corresponding machine count data for that period. By multiplying this ratio to the average machine count, an estimate of the average daily traffic was obtained.

In analyzing the data from the classifications and the interviews, it was decided to use ratio estimates as opposed to any alternative type of analysis since the theory of ratio estimates was best suited to the type of data obtained in the study. The particular ratio estimates needed for this

^{2/} Ibid, Item 2, for the table of data discussed in this paragraph.

study were: R, the ratio of gallons of gas to out-of-state boats; and S, the ratio of out-of-state boats to traffic. Appendix B, Item 3 discusses the formulae used in obtaining the estimates of total gas purchased in Michigan for use in boats entering Michigan by the road network. The results are discussed in "Findings" below.

The data was also broken down into segments concerning the Upper Peninsula and the Lower Peninsula to see if there were any major differences between the two regions. These two segments were analyzed in the same manner as the total data was analyzed in the description above.

Findings:

From the data collected in this survey, the following estimates of marine fuel consumption were obtained:

	UPPER PENINSULA	LOWER PENINSULA	TOTAL
Boats	18,339	52,962	71,492
90% Confidence Interval on Number Of Boats	(13,955, 22,722)	(39,313, 66,610)	(57,532, 85,452)
Gas (In Gallons)	81,781	405,262	497,341
90% Confidence Interval on Amount of Gas	(30,345, 133,216)	(90,641, 719,882)	(180,492, 814,190)

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In Appendix B, Item 4, the calculation of the 90% confidence interval is discussed. Also included there is the explanation of why the individual estimates for the Upper Peninsula and Lower Peninsula do not sum to the estimate for the entire state.

Discussion:

There seems to be no stable relationship between the amount of gasoline used and the length of the boats nor between the amount of gas used and the length of stay in Michigan. This seems to be due to the wide variety of reasons for which the owner brings his boat into Michigan. Some were merely passing through the state, and others may have intended to use their boat but were prevented from doing so by inclement weather.

Segment 3 Survey of Out-of-State Boats Entering
Michigan via the Waterways

Prepared by the Waterways Division,
Department of Natural Resources

Many out-of-state boats buy fuel at Michigan marinas on the Great Lakes due to their easy accessibility by water. The purpose of this segment of the study is to estimate how many gallons of gasoline, purchased in Michigan, are used by out-of-state boats that enter the state by water.

To obtain the desired information, a sample survey was taken of Great Lakes marinas. A selected number of marinas, at various locations, were asked to keep records of all marine fuel sales to out-of-state boats. All wholesale suppliers of fuel to Michigan Great Lakes marinas were contacted and asked to supply information on total gasoline sales in 1970. From the marina survey, a percentage (of sales to out-of-state boats) was established relative to total sales. This percentage was then expanded to the total marine fuel sales (as measured in the fuel wholesalers survey) of Great Lakes marinas to obtain an estimate of total gallons sold to out-of-state boats.

The survey in this segment of the study was conducted by the Recreation Research and Planning Unit of the Department of Parks and Recreation Resources at Michigan State University, under contract to the Waterways Commission. Their report, while too lengthy to be included in this study,

was conducted according to specifications outlined by the Waterways Commission and is the source of all information contained in this segment. All supplementary material for this segment is to be found in Appendix C in Section III of this study.

Procedures:

Marina Survey

The first step in this survey was to develop a reasonably up-to-date list of all Great Lakes marinas that sell gasoline to boaters. Revision of a list provided by the Waterways Commission and one compiled in a previous Recreation Research & Planning Unit study ^{1/} provided a final list of the names and addresses of 549 marinas.

An introductory letter and questionnaire was sent to each of the 549 marinas to obtain further information as to their suitability for inclusion in the survey. ^{2/}

Responses to the initial questionnaire reduced the number of marinas appropriate for inclusion in the survey to 200. Marinas were eliminated because of non-response, insufficient addresses and plans not to sell marine fuel in 1970.

^{1/} 1970 Great Lakes Recreational Boating Facilities Inventory, Recreation Research & Planning Unit, 1970 (unpublished).

^{2/} See Appendix C, Item 1, for copy of the initial questionnaire.

Since little data was available to create a structured sample, it was decided to hand-pick a sample of 125 marinas that would represent all sizes and types of marinas in each geographic region.

The sample marinas were sent a letter soliciting cooperation and a reply postcard. Initially only 27 cards were returned with 19 indicating a willingness to cooperate. Personal visits to each of the 125 marinas by members of the research staff increased the final number of participants to 85. Two additional visits were made to the lower peninsula facilities to check on the records being kept and emphasize the importance of the survey.

A total of 31 marina owners kept sales records during the 1970 season, but 11 of these were able to provide data for only part of the season.

In order to expand the data from the 11 marinas which had submitted data for only part of the season, the seasonal distribution of sales to out-of-state boats at marinas which had kept complete records was examined. The records from four marinas which represented four different regions of the state's Great Lakes shoreline and which had excellent records were selected as a basis for interpolation. Their out-of-state sales for the season were aggregated into four periods: (1) 1970 sales before July 1; (2) sales in July, 1970; (3) sales in August, 1970; and (4) sales in September, 1970. The percentage of the total out-of-state boat sales

that occurred in each of these four periods was calculated for each of the four marinas. The four percentages obtained for each of the periods were then averaged. These averages indicated that, for the State as a whole, 2 percent of the out-of-state business occurred before July 1, 50 percent of the out-of-state business occurred in July, 44 percent of the out-of-state business occurred in August, and 4 percent of the out-of-state business occurred in September. These percentages were then applied to the partial records in order to give an estimate of the probable total gasoline sales to out-of-state boats. Appendix C, Item 2 lists each of the marinas where partial records were obtained and shows the application of the appropriate percentages in order to estimate the total out-of-state sales for the season.

The next step was to apply the data from the 20 marinas which kept full records, together with the crude, season-long percentage estimates from other operators, and the estimates developed by interpolation of the 11 partial records, in order to obtain estimates of the probable percentages of gasoline sales to out-of-state boats by those marinas which did not provide records. This was done by plotting the percentages of out-of-state sales on a map of Michigan.

This map was examined and geographical zones delineated where the percentages of out-of-state sales were somewhat uniform. As would be expected, marinas

closest to Indiana, Wisconsin and Ohio had the highest percentages of out-of-state business. Saginaw Bay had the lowest percentages. The Traverse City to Cheboygan area also had low percentages, which is rather surprising because of the high level of tourism and boating activity in those areas. Fourteen zones with reasonably homogeneous out-of-state sales percentages were delineated and identified by the names shown in the table below and Appendix C, Item 3.

OUT-OF-STATE GASOLINE SALES PERCENTAGES BY ZONES ^{3/}

Zone #	Name of Zone	% Out-of-State Sales
1	Lake Erie	52.0%
2	St. Clair River - Lake St. Clair - Detroit River	6.6%
3	Lower Lake Huron	9.3%
4	Saginaw Bay	0.1%
5	Upper Lake Huron	9.1%
6	Traverse City - Cheboygan	4.7%
7	Pentwater - Leland	25.9%
8	Douglas - Saugatuck - Grand Haven	22.2%
9	South Haven - Holland	23.1%
10	St. Joseph	17.0%
11	Indiana Border Area	50.0%
12	Escanaba - Gladstone - Menominee	14.5%
13	Lake Mich. (U.P.) - Mackinac Str. - Lake Huron (U.P.)	17.0%
14	Lake Superior	16.6%

^{3/} Gasoline Consumption Study for Out-of-State Recreational Boats Operating in Michigan's Great Lakes Waters, Recreation Research & Planning Unit, M.S.U., 1971, pp. 20.

Each of the Michigan Great Lakes marinas selling gasoline was then listed in its respective zone, and an estimated percent of out-of-state business for each zone was calculated by averaging the percentages of out-of-state business from the actual records kept and from the operator's crude estimates. This estimated average percentage of gasoline sales to out-of-state boats for each zone was then applied to the total gasoline volume sold during the season ^{4/} by each marina which did not provide records, in order to obtain an estimate of the total gallons sold by that marina to out-of-state boats.^{5/}

Survey of gasoline wholesalers

As with the marina survey, the initial step in surveying the marine fuel wholesalers was the compilation of a list of all such operations. Information from the initial Marina Questionnaire (Appendix C, Item 1, question 4) and the Great Lakes Recreational Boating Facilities Inventory (see footnote 1) provided a partial list.

Further investigation showed that the wholesaling system was more complicated than anticipated. Some companies sold directly to marinas, others to a "jobber" or middle man who then sold to individual marinas. It was decided that both wholesalers and parent companies should be contacted. Complications arose because of duplication of records between company offices and wholesale "jobbers". Many wholesalers submitted a figure of total fuel sold without

^{4/} The total gasoline volume sold by each marina was determined by the wholesaler survey as described in the next paragraph.

^{5/} Gasoline Consumption Study for Out-of-State Recreational Boats Operating in Michigan's Great Lakes waters, Recreational Research & Planning Unit (previously cited), Appendix A, gives a complete listing of Great Lakes marinas with estimated out-of-state fuel sales.

indicating the names of their marina customers; some included inland marinas.

An initial list of 126 wholesalers was reduced to a final list of 90. This list removed most duplication of records by including wholesalers and oil company offices at the appropriate administrative levels. A follow-up procedure of one letter and one phone call obtained a final response from 81 of the 90 offices. In addition, 38 marinas whose wholesalers were unknown, were contacted by mail or telephone. Eleven (11) provided their 1970 sales records.

As a result of the survey, sales records were obtained for 247 of the estimated 297 Michigan Great Lakes marinas. These sales records provided the total gallon sales of each marina, a percentage of which was computed as the sales to out-of-state boats on the basis of the marina survey. Also records were obtained from both 1969 and 1970 where possible, in order to explore the possibility of fluctuation in annual sales (See "Discussion" section).

Findings: ^{6/}

The estimated amounts of gasoline sold to out-of-state boats in 1970 for each zone are shown in the table below.

**ESTIMATED TOTAL 1970 GASOLINE SALES TO OUT-OF-STATE
BOATS ENTERING BY WATER**

Zone #	Name of Zone	1970 Gallons
1	Lake Erie	92,341
2	St. Clair River - Lake St. Clair - Detroit River	295,593
3	Lower Lake Huron	19,400
4	Saginaw Bay	272
5	Upper Lake Huron	26,569
6	Traverse City - Cheboygan	36,185
7	Pentwater - Leland	104,828
8	Douglas - Saugatuck - Grand Haven	75,007
9	South Haven - Holland	110,789
10	St. Joseph	20,179
11	Indiana Border Area	37,422
12	Escanaba - Gladstone - Menominee	8,906
13	Lake Michigan (U.P.) - Mackinac Str. - Lk. Huron (U.P.)	19,755
14	Lake Superior	11,708
STATE TOTAL		858,954

^{6/} From Gasoline Consumption Study, pp. 24

Discussion: ^{7/}

Year to year fluctuation in sales

It had been recognized at the time of the survey that 1970 might not be a typical boating season. The publicity that accompanied the announcement of the discovery of abnormally high concentrations of mercury in fish caught in the Lake St. Clair, Detroit River, Lake Erie area, together with the ban on fishing in these waters, probably had a considerable impact on boating. In addition, some marina operators indicated by letter or during field interviews that business in 1970 was somewhat poorer than 1969, probably due to the generally less favorable economic conditions.

Total gasoline sales volumes for 1969 and 1970 were, therefore, requested from wholesalers (and in some cases individual marinas) as described earlier in this segment. Both 1969 and 1970 values were secured for 151 of the 200 marinas which sold gasoline in 1970. The figures were aggregated for the 14 sales zones and the percentage difference in sales between 1969 and 1970 calculated for each zone or combination of zones as shown in the table below. (In some cases the data for zones had to be combined because wholesalers did not break down the 1969 data.)

The variation in the amount of boating done from year-to-year probably affects all phases of the present gasoline consumption study and should receive more attention than time permitted for this report.

^{7/} Ibid., pp. 22-23, 25-28

COMPARISON OF 1969 AND 1970 TOTAL GASOLINE SALES FOR 151 MARINAS
BY ZONES OR COMBINATIONS OF ZONES

Zone Nos.		1969 Gallons	1970 Gallons	% Difference
1	Lake Erie	169,520	146,315	-13.7
2	St. Clair River - Lake St. Clair - Detroit River	2,209,426	1,858,095	-15.9
3,4, & 5	Lake Huron	657,903	616,805	- 6.3
6,7,8,9, 10 & 11	Lake Michigan	1,362,778	1,379,369	+ 1.2
12,13,& 14	Upper Peninsula	120,927	100,347	-17.0
TOTALS		4,520,554	4,100,931	- 9.3

The possible adjustments in the 1970 estimated gasoline sales volumes to out-of-state boats implied above (based on differences between 1969 & 1970 total sales) is founded on an unproven hypothesis. The hypothesis is that the proportion of sales made to out-of-state boats varies directly with the fluctuation in total marina gasoline sales. Although this appears a reasonable assumption, it may be incorrect. For example, if the alleged mercury pollution problem in Michigan was not as widely publicized in other states, it may have had less effect on out-of-state boaters than it did on Michigan boaters. Similarly, Michigan Great Lakes boaters may have been affected more by the economic situation in 1970 than boaters from other states where the automobile industry has less influence. The time-series data necessary to check on

the relationship between out-of-state and total sales volumes is not presently available. It could be obtained if a number of strategically located sample marinas could be persuaded to keep out-of-state boat sales records for some specified test periods each season.

Even if the nature of this relationship cannot presently be determined, an examination of total marina sales over a number of years is warranted in order to detect total sales trends. This would answer the question of how typical or atypical were 1969 and 1970 with regard to boating behavior. If both years were below normal, it would mean that even the estimated 1969 sales values given at the beginning of this chapter are lower than the values that would be obtained in a "normal" year.

Sample size

Since no similar studies of gasoline sales have been conducted, it is not possible to estimate the probable variance in the proportion of gasoline sold to out-of-state boats in different zones of the state and arrive at a recommended minimum sample size. It is conceivable that if such data were available it would show that the sample size for the present study (10% full records; 15.5% including partial records) was quite adequate. However, due to the large number of variables affecting the proportion of gasoline sales to out-of-state boats (geographic location, position relative to other marinas, location relative to main boating routes, services offered, tourist attractions, advertising, etc.) it appears likely that the

variance is high and a large proportion of the marinas would have to be sampled to guarantee reliability. This is why the original intention was to sample at least 50% of the 200 marinas which sell gasoline.

It is recommended that in future surveys of this kind, the study be designed in such a way that it will obtain a much larger sample. In view of the large number of personal contacts made with marina owners during this present study, it does not appear likely that additional field staff travelling around to stimulate cooperation would have much beneficial effect. Therefore, it is suggested that three possible ways of obtaining a larger sample be investigated, namely:

- a) obtaining support from marina owner associations or local groups,
- b) paying marina operators to collect the data,
- c) employing local persons to gather the information.

If a reasonably large sample could be obtained for one season, it would likely be possible to design a sampling system for future studies which would require that data only be gathered on specific sample days. This would likely improve marina operator cooperation in subsequent studies.

Testing the reliability of data gathered

Interdependent with sample size in determining the overall reliability of this study is the validity of the actual individual marina records obtained. During the field work, the study staff tried to gain an impression of the

quality of the data on gasoline sales to out-of-state boats gathered by the cooperating marinas. In some cases, it was apparent that the marina operators were personally interested in obtaining accurate data, and therefore, the information they supplied is not likely to be seriously in error. In other cases, the operators were less highly motivated or were periodically so busy it is doubtful that their records of out-of-state sales were complete. However, the field staff felt that in these cases it is unlikely that the operators added estimated out-of-state sales in order to bolster their totals. Rather, it is probable that these operators tended to miss some out-of-state boats; therefore, the records they supplied would lead to conservative estimates of total sales to out-of-state boats.

Trailered Boats

The present study was intended to estimate the total volume of gasoline sold at Michigan's Great Lakes marinas to out-of-state recreational boats which entered the State by water. Boats registered out-of-state which entered by highway on a vehicle or trailer were not to be included, since another Segment of the study was designed to obtain data on this group of boaters. In practice, it was found that there was no practical way of distinguishing between gasoline sales to "trailered" and "non-trailered" out-of-state boats so the estimates probably include some gasoline sold to the former. However, the field staff reported that few out-of-state

boats using the Great Lakes marinas appeared to be small enough to be "trailerred." In addition, "trailerred" boats generally had comparatively small motors and low fuel consumption rates compared to the larger craft capable of cruising Great Lakes waters. It is felt, therefore, that "trailerred" boats probably were the source of a comparatively small error of over-estimation in this study. It is recommended that if a check on data reliability is carried out in future studies, it should include a method of determining the proportion of "trailerred" boat gasoline sales included in the data recorded.

Segment 4 Survey of Rental Boats
Registered in Michigan

Prepared and Conducted by
Transportation Planning Division
Department of State Highways

The purpose of this segment of the study is to estimate the amount of marine fuel consumed by rental boats registered in Michigan. It was decided in the planning of this segment that a group of five or more boats belonging to a single owner be classified as a "livery" and that such boats be considered separately from registered boats used for private purposes. The rationale behind this separation was that "livery" boats had a high likelihood of being rental boats and, as such, would tend to be higher-than-average users of gasoline.

As originally conceived, the livery survey was to consist of a mail questionnaire distributed to 100% of the livery owners. However, it quickly became apparent that a mail questionnaire simply would not do the job. On the basis of a few preliminary personal interviews of livery owners, it seemed that the unreliability of responses to a mail-out would be unreasonably high due to three factors: 1) some livery owners feared that the study information could be used for tax purposes; 2) some kept no written records whatsoever; and 3) a large number rent no motors with their boats but may still have data pertinent to estimating the amount of gasoline used by the person who rents the boat.

For these reasons, the survey had to rely on personal interviews by trained Department of State Highways interviewers.^{1/} The actual procedure for conducting the survey is described below. All supplementary material for this segment is to be found in Appendix D in Section III of this study.

Procedures:

A survey universe of all livery boats was obtained from the Michigan boat register. The registration numbers of all boats belonging to a "livery" were then inserted into a utility tape maintenance program, which generated a file of all records pertaining to this classification. In order to get the name and address of each livery owner, one registration number from each owner-group was selected and an address record generated for the owner.

Simultaneously, the file of livery boats was submitted for a pass with a special "Boat Survey Analysis Program," which provided the basic statistics for the file categorized by propulsion type, length class, and county of registration. The categories were those used in both the Pre-Study (See Appendix A, Item 1) and the in-state survey in Segment 1. It was found that the great majority -- in fact, 76.6% -- of all livery boats belong to the category characterized by outboard propulsion and length in the

^{1/} See Appendix D, Item 1 for copy of interview questions.

range 12 - 19.99 feet. Therefore, it became possible to set the sample size using the sample standard deviation for this propulsion-length category from the Pre-study. The pertinent Pre-study data for the category is:

$$\bar{X} = \text{average gallons consumed/boat} = 63.07$$

$$X = \text{sample standard deviation of category} = 110.62$$

It was felt that a more accurate estimate could be obtained by sampling owners of liveries and gathering data on all boats owned by them: there are so few "livery" boats in the other fourteen categories (See figure 1) that a very good chance existed of sampling no boats at all from these cells. Thus it must also be noted that the mean number of livery boats per livery owner is 9.005, rounded for convenience to $\bar{B} = 9$.

Finally, it seemed unfeasible to attempt to limit the sample standard deviation of the estimator to less than three percent (.03) of the sample mean.

Therefore, if:

$$n = \text{number of owners to be sampled;}$$

$$\text{s.d.} = \text{sample standard deviation of consumption for the class outboard, 12-19.99 feet. (pre-study)} = 110.62 \text{ gallons.}$$

$$\bar{X} = \text{sample mean consumption for this category (pre-study)} = 63.07 \text{ gallons.}$$

$$\bar{B} = \text{mean number of livery boats per livery owner} = 9 \text{ boats}$$

the minimum number of owners in the sample can be found by solving the

following equation for n:

$$\frac{\text{s.d.}}{\sqrt{9n}} \leq .03\bar{X}$$

forcing $n \geq 307$. This amounts to a sample of 18.9% of the universe of livery owners.

Since there was no reason to suspect systematic bias on the owner-file, the sample was taken as a systematic sample; i.e., every fifth owner was selected, starting with a randomly selected record.

Each livery owner was contacted by telephone, informing them of the study and of the fact that an interviewer would be visiting them. If the owner wished to volunteer the information at the time of the telephone call, it was taken at that time; in practice, many people said that they had the information and would prefer to volunteer it rather than have an interviewer call.

In reference to the interview form itself (See Appendix D, Item 1), it should be noted that question 1 was included mainly for the purposes of introduction and identification. With regard to questions 2-4, if the respondent felt that it was easier to estimate the total for each propulsion-length category than to estimate for a typical boat in each category, the interviewer noted that fact in the margin.

The results of the interview survey are presented below.

Findings:

The survey results are given according to boat length and type of propulsion. The generic variables for each propulsion - length category are defined as follows:

N = Number of livery boats in the category

n = Number of sampled boats in the category

\bar{G} = average number of gallons of gasoline consumed by a boat in the category

s.d. = standard deviation of the estimated \bar{G} for the category.

FIGURE 1

PROPULSION LENGTH	INBOARD	OUTBOARD	SAIL/ AUXILIARY MOTOR
0-11.99 ft.	N = 61 n = 0 \bar{G} = 0 s.d. = 0	N = 2857 n = 15 \bar{G} = 10.27 s.d. = 7.69	N = 4 n = 3 \bar{G} = 0.00 s.d. = 0.00
12-19.99 ft.	N = 147 n = 6 \bar{G} = 128.33 s.d. = 68.71	N = 11,166 n = 2806 \bar{G} = 17.72 s.d. = 0.86	N = 9 n = 0 \bar{G} = 0 s.d. = 0
20-29.99 ft.	N = 166 n = 3 \bar{G} = 575.00 s.d. = 573.02	N = 76 n = 15 \bar{G} = 145.67 s.d. = 63.15	N = 4 n = 1 \bar{G} = 60.00 s.d. = 0
30-39.99 ft.	N = 56 n = 0 \bar{G} = 0 s.d. = 0	N = 2 n = 0 \bar{G} = 0 s.d. = 0	N = 1 n = 0 \bar{G} = 0 s.d. = 0
40 + ft.	N = 10 n = 1 \bar{G} = 300.00 s.d. = 0	N = 2 n = 0 \bar{G} = 0 s.d. = 0	N = 1 n = 1 \bar{G} = 0.00 s.d. = 0.00

It is important to note that the estimates of the population mean, variance, and standard deviation can be calculated only from existing data; hence, only eight of the fifteen categories are represented. However, the combined population of the other 7 categories comprises only one percent of all livery boats. Therefore, the estimates of the population mean, population

variance, and the standard deviation of the sample mean (the estimator of the true mean) are as follows, calculated on the basis of all categories for which elements of the population exist in the sample:

let N_n = number of elements in all categories possessing sample points.

\bar{G}_n = combined estimate of the mean based on the above categories.

S_n = standard deviation of \bar{G}_n based on the above categories.

$$\begin{aligned} \text{Then } \bar{G}_n &= \frac{\Sigma (\text{number of elements in category}) \times (\bar{G} \text{ for the category})}{N_n} \\ &= 24.46 \end{aligned}$$

$$\begin{aligned} S_n &= \left(\frac{\text{pooled variance over all the above categories}}{N_n} \right)^{1/2} \\ &= 3.0728 \end{aligned}$$

The estimates of the total for the population, (G_{liv}, S_{liv}) are obtained by:

$$\begin{aligned} G_{liv} &= N_{liv} \bar{G}_n \text{ (where } N_{liv} = \text{population size} = 14,562) \\ &= 356,214.19 \text{ gallons} \end{aligned}$$

and

$$\begin{aligned} S_{liv} &= \sqrt{N_{liv} S_n} \\ &= 370.47 \text{ gallons.} \end{aligned}$$

A 95% confidence interval on the true total gallons of gasoline consumed by livery boats is as follows:

$$\begin{aligned} 356,214.19 &= (1.96) (370.47) \\ &= 356,214.19 \pm 726.12 \\ &= [55,488.07, \quad 356,940.35] \end{aligned}$$

The estimate obtained from this survey of the fuel consumption of livery boats registered in Michigan is 356,214 gallons.

Discussion

As expected at the outset of the survey, the average amount of gasoline consumed by livery boats differed from that of the "owner-user" registered boats surveyed in Segment I. Relative to the rest of the boat population, livery boats consume very little gas.

This pattern of consumption was largely consistent throughout most of the state but with a significant variation for the Lake St. Clair area. ^{2/}

The lower mean consumption per boat for that region may be reflective of the fishing ban imposed in that area.

The major contributing factor to the statewide trend of low livery boat gasoline consumption seems to be that a growing number of livery owners are finding that renting motors with their boats is uneconomical, due to high repair costs and the carelessness of renters.

^{2/} Ibid., Item 2

One final detail should be clarified here concerning the class: Outboard, 12 - 17.99 feet. Of the 614 boats and 66 owners included in the category of zero-usage, only 24 owners (251 boats) indicated that the renter was allowed to provide his own motor if he wished. Since there was no way of estimating such consumption, the response was deleted from the sample. The only exceptions were the cases in which the owner gave data for his own personal motor, which were accepted as being representative for all his boats. Lacking this, the only alternative to deletion would have been the setting of the consumption for all boats for such an owner to zero. However, not all zero-use responses were deleted. In the majority of cases of zero-use, the respondent indicated to the interviewer that no motors at all were used on his boats.

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Segment 5 Survey of Documented Boats
 Purchasing Fuel in Michigan

Prepared & Conducted by the Waterways
Division, Department of Natural Resources

Any yacht or boat of five net tons or more, used for recreational purposes only, can be registered with the U.S. Coast Guard in lieu of state registration. Boats registered in such a manner are said to be "documented" boats. The purpose of this segment of the study is to estimate the amount of marine fuel purchased annually in Michigan by these boats.

A list of documented boats was provided by the U.S. Coast Guard consisting of boats from all documented ports in Michigan and the surrounding ports of Milwaukee, Duluth, Chicago and Toledo, as of December, 1967.

Procedure:

A 100% sample of documented boats was chosen for the survey for two reasons; the number of boats is small (about 2,000) and the gas consumption was assumed to be relatively high for the larger boats.

From the original list, the 2,011 questionnaires and gas logs were mailed out in July, 1970. ^{1/} From this first mailing, 335 usable questionnaires were returned. A second reminder mailing to 1,218 addresses returned 467 usable questionnaires for a total of 802 usable questionnaires out of the original 2,011, for a 39% return. ^{2/}

Because the registration list from the Coast Guard was from December 1967 (it had just recently been redone but was the newest list available), many

^{1/} See Appendix E, Items 1 & 2, for copies of the questionnaire-gas log and introductory letter.

^{2/} ibid., Item 3 for copy of the reminder letter.

questionnaires were returned by the Post Office because of non-delivery, or the respondent indicated that he had sold his boat, destroyed the boat, or no longer used the boat. The following table shows the returns for the first and second mailings.

<u>First Mailing</u>	<u>Second Mailing</u>	
221	253	Questionnaires with usable fuel records
<u>114</u>	<u>214</u>	Questionnaires with boat not used, used out of state, etc.
335	467	TOTAL RESPONDENTS
TOTAL 802 respondents out of 2,011 documented boats		

A telephone follow-up of non-respondents was used to check for possible bias in the sample. From the total 719 documented boat owners who did not respond to either the first or second mailings, a 10% sample was drawn of 72 names and addresses for which telephone numbers were available. These 72 people were phoned and asked about their gasoline consumption for 1969 and 1970.

Thirty documented boat owners were finally contacted about their boats. For 1970, the 30 boats used 9,945 gallons or 331.5 gallons per boat. For 1969, 29 boats used 10,620 gallons or 366.2 gallons per boat. A chi square test of average gasoline consumption revealed no significant differences between the mail respondents and non-respondents contacted by telephone. In every case, the non-respondents consumption was higher than the respondents indicating that any bias in the total documented boat gasoline usage would be on the conservative side, that is, the 2,011 documented boats consumed at least 626,170 gallons in 1969 and 625,774 gallons in 1970. The following table compares respondents and non-respondents gasoline consumption data.

	RESPONDENTS	NON RESPONDENTS
1969	802 BOATS 249,721 GALLONS 311.4 GAL/BOAT	29 BOATS 10,620 GALLONS 366.2 GAL/BOAT
1970	802 BOATS 249,563 GALLONS 311.2 GAL/BOAT	30 BOATS 9,945 GALLONS 331.5 GAL/BOAT

Findings:

The results of the survey are given below for the first and second mailings and the total sample, for both 1969 and 1970. The "total documented boats" figures are the 1969 and 1970 totals of the sample expanded to the entire documented boat population.

The figure of primary interest to this study is the 1970 estimate of fuel consumption by all documented boats which is 625,774 gallons.

	AMOUNT OF GASOLINE USED	
	1969	1970
First Mailing	335 boats used 110,363 gallons	335 boats used 102,490 gallons
Second Mailing	467 boats used 139,358 gallons	467 boats used 147,073 gallons
Total Sample	802 boats used 249,721 gallons	802 boats used 249,563 gallons
Total Documented Boats	2,011 boats used 626,170 gallons	2,011 boats used 625,774 gallons

Appendix A (Segment 1)

Item 1 - Survey Pre-Study

Item 2 - Survey letter

Item 3 - Survey questionnaire

Item 4 - Survey follow-up letter

Item 1

Privately Used Boats Registered
To Michigan Owners

Pre-Study

1. Preliminaries

The pre-study was taken as a stratified sample of 10,000 out of a total of 437,315 motorboats registered by the office of the Secretary of State. Stratification was done on three propulsion types - inboard, outboard, and sail with an auxiliary motor - and five length classes -- 0-11.99 ft., 12-19.99 ft., 20-29.99 ft., 30-39.99 ft., and 40+ ft. -- with allocation to each stratum being proportional to the size of the stratum. The rate of usable return was a remarkably good 50.99%.

2. Sample mean, estimate of total, variance and standard deviation of the estimator.

According to the results of the pre-study, the average boat registered in Michigan used 65.4174 gallons of taxable gasoline in 1969. This figure was used in obtaining an estimate \hat{G} of G = total gallons of gasoline consumed by motorboats registered in Michigan of

$$\hat{G} = 28,631,625.29 \text{ gallons, rounded to two}$$

decimal places. The variance of the estimator was computed to be

$$\text{Var } (\hat{G}) = 655,813,168,317.19 \text{ gallons; i.e., a}$$

standard deviation of

$$\text{s.d. } (\hat{G}) = 87,959.82 \text{ gallons}$$

The variance can be further analyzed by three types of category breakdowns, namely (1) by propulsion type (all lengths combined), (2) by length stratum (all propulsion types combined), and (3) by both propulsion type and length stratum.

Define the following generic variables for each category:

N = number of boats registered in 1969 in the category.

n = number of usable replies received in the category.

\bar{X} = sample mean (i.e., average number of gallons of gasoline per replying boat) in the category.

s.d. = (sample) standard deviation of the sample mean within the category.

A. Propulsion Type

	<u>Inboard</u>	<u>Outboard</u>	<u>Sail/aux.</u>
N:	34,510	399,576	3229
n:	345	4,729	33
\bar{X} :	315.50	49.65	19.51
s.d.:	27.46	1.41	9.19

B. Length Category

ft:	<u>0-11.99</u>	<u>12-19.99</u>	<u>20-29.99</u>	<u>30-39.99</u>	<u>40+</u>
N:	138,408	274,876	19,728	3,729	604
n:	1,463	3,323	254	28	11
\bar{X} :	17.80	65.92	189.11	691.85	1593.18
s.d.:	1.00	1.98	17.04	118.33	433.40

C. Combined			
ft.	Inboard	Outboard	Sail/aux.
0-11.99	N = 1,067 n = 10 \bar{X} = 2.2 s.d. = 1.88	N = 137,341 n = 1,453 \bar{X} = 17.90 s.d. = 1.00	
12-19.99	N = 16,552 n = 135 \bar{X} = 140.66 s.d. = 14.47	N = 256,731 n = 3,171 \bar{X} = 63.07 s.d. = 1.96	N = 1,563 n = 12 \bar{X} = 37.67 s.d. = 1.70
20-29.99	N = 13,038 n = 149 \bar{X} = 266.93 s.d. = 25.775	N = 5,651 n = 93 \bar{X} = 83.96 s.d. = 76.92	N = 1,039 n = 12 \bar{X} = 37.67 s.d. = 23.00
30-39.99	N = 3,316 n = 41 \bar{X} = 793.63 s.d. = 96.78	N = 166 n = 5 \bar{X} = 114.00 s.d. = 76.92	N = 247 n = 2 \bar{X} = 50.00 s.d. = 35.36
40+		N = 604 n = 11 \bar{X} = 1593.18 s.d. = 433.50	

3. 95% confidence intervals on G = total number of gallons of gasoline used by Michigan - registered boats in 1969.

A. Two-sided:

$$28,459,224.04 \text{ gals} \leq G \leq 28,804,026.54 \text{ gals.}$$

(Interpretation: if the same kind of sample were taken a great many times, it would be discovered that in at least 95% of the cases, the true value of G would lie between the upper and lower bounds of the confidence interval calculated for the sample.)

B. One-sided:

$$G \leq 28,781,319.20$$

(Interpretation: upon repetition of this sampling procedure a great many times, it would be discovered that in 95% of the cases, the true value of G would be less than the upper limit calculated for the sample.)

4. Conclusions

In 1969, there were 4,404,193,000 gallons of gasoline sold in Michigan. However, not all of that is within the bounds of this study. Exclude:

Shrinkage Allowance	114,942,000 gals.
Exempted Sales	213,975,000
Non-highway Use	127,988,000
Aviation	197,735,000
Diesel Fuel	<u>184,285,756</u>
	838,925,765 gals.,

that leaves a total of 3,565,267,244 gallons of gasoline (no diesel

fuel) which, according to the records of the Department of the Treasury, were taxed as highway use under the 1968 Motor Fuel Tax Laws.

Therefore, according to the results of this pre-study, it can be said with 95% confidence that no more than nine-tenths of one percent -- actually, $(28,781,319.20 \div 3,565,267,244) = .00807 = 0.807\%$ -- of gasoline taxed as for highway use are used by pleasure boats registered with the Secretary of State of the State of Michigan.

Item 1
(continued)

Post Office Drawer K
Lansing, Michigan 48904



address
label
here

identification
label
here

QUESTIONNAIRE

1. Did you use this boat in Michigan during 1969? Yes No
If this boat was used in Michigan waters during 1969, please answer the following to the best of your ability:
2. What is the horsepower rating of the motor (or motors) used with this boat?
#1 _____ H.P.; #2 _____ H.P.; #3 _____ H.P.
3. Approximately how many gallons of gasoline were purchased in Michigan for use with this boat during 1969? _____ gallons.
4. In all, how many boats are registered in Michigan under your name? _____ boats.

MICHIGAN MARINE FUEL STUDY
QUESTIONNAIRE

(1-6)
(7-8, 9-10)
(11)

1. Are you still the owner of the above boat?

Yes _____ No _____ Comments _____

(12)

2. Was this boat used in Michigan waters during the period from October 1, 1969, to September 30, 1970?

Yes _____ No _____ Comments _____

(13)

If your answer to question 2 was "yes", please answer the following to the best of your ability:

3. What is (are) the horsepower rating(s) of the motor(s) used on this boat?

Motor #1 _____ h.p.

(14-18)

Motor #2 _____ h.p. (if applicable)

(19-23)

Motor #3 _____ h.p. (if applicable)

(24-28)

4. How many gallons of gasoline were purchased in Michigan during the period from October 1, 1969, to September 30, 1970 for use with this boat?

_____ gals.

(29-35)

5. Did you use much more _____

Somewhat More _____

About the Same _____

Somewhat Less _____

Much Less _____

Don't Know _____

} gasoline during the year October 1, 1968 to September 30, 1969 than you did last year (October 1, 1969, to September 30, 1970)?

(36)

Michigan Marine Fuel Tax Study Questionnaire Introductory Letter

COMMISSION:

CHARLES H. HEWITT,
CHAIRMANWALLACE D. NUNN,
VICE CHAIRMAN

LOUIS A. FISHER

CLAUDE J. TOBIN

STATE OF MICHIGAN



WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS

STATE HIGHWAYS BUILDING - POST OFFICE DRAWER K - LANSING, MICHIGAN 48904

HENRIK E. STAFSETH, DIRECTOR

Dear Registered Boat Owner:

In order to distribute fuel tax revenue properly, a cooperative study is being conducted by the Department of Natural Resources, the Department of State Highways, and the U.S. Department of Transportation to determine the proportion of fuel used for boating in Michigan. Your boat has been randomly selected from the registration list as a member of the study sample.

You can provide valuable information for this study by filling out the enclosed questionnaire and returning it to us at the earliest possible opportunity. Please note that the requested information should pertain only to the period from October 1, 1969, through September 30, 1970.

Your cooperation is vital to this analysis of fuel consumption. All information will be used only for this study and will be kept strictly confidential. Thank you for your participation.

Sincerely,

A handwritten signature in cursive script, reading "Henrik E. Stafseth".

HENRIK E. STAFSETH
Director

COMMISSION:

STATE OF MICHIGAN

CHARLES H. HEWITT,
CHAIRMAN

WALLACE D. NUNN,
VICE CHAIRMAN

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CLAUDE J. TOBIN



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DEPARTMENT OF STATE HIGHWAYS

STATE HIGHWAYS BUILDING - POST OFFICE DRAWER K - LANSING, MICHIGAN 48904

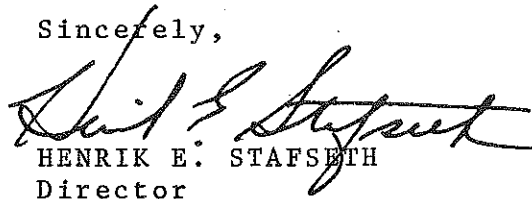
HENRIK E. STAFSETH, DIRECTOR

Dear Registered Boat Owner:

Some time ago, we requested your assistance in determining the proportion of motor fuel used for boating in Michigan. In case that questionnaire has been misplaced, another is enclosed for your convenience. We would greatly appreciate your taking a moment to fill it out and mail it back to us in the envelope provided.

If your reply is already on the way, please disregard this letter. We thank you for your cooperation and apologize for troubling you again.

Sincerely,


HENRIK E. STAFSETH
Director



Appendix B (Segment 2)

- Item 1 - Times & dates of interviews
- Item 2 - Average traffic counts
- Item 3 - Estimating total gas consumption
- Item 4 - Remarks on terminology

ITEM 1

B-1

STA. NO.	CLASS. ONLY						INTERVIEW & CLASS			CLASS ONLY	INTERVIEW & CLASS			CLASS ONLY
	12M-7A	7A-11A	11A-1P	1P-3P	3P-7P	7P-12M	7A-1P	1P-7P		12M-7A	7A-1P	1P-7P	7P-12M	
1	6-26	6-3	6-8	6-4	6-9	7-10	7-17	7-22	Sun	6-14	8-23	7-26	7-12	
	8-28	7-29	8-3	7-30	8-4	7-24	8-27	8-24	Sat	6-13	8-22	7-25	7-11	
2	7-7	6-4	6-9	6-3	6-8	7-13	7-22	7-17	Sun	6-7	9-13	6-28	8-2	
	9-11	7-30	8-4	7-29	8-3	8-6	9-21	8-25	Sat	6-13	8-22	7-25	7-11	
3	7-6	6-5	6-10	6-15	6-23	7-14	7-23	7-24	Sun	6-21	9-27	9-20	9-20	
	9-10	7-31	8-5	8-10	8-18	9-2	8-28	8-26	Sat	6-20	7-25	6-27	8-29	
4	7-22	6-15	6-23	6-5	6-10	6-30	6-29	7-24	Sun	7-19	9-27	7-26	8-16	
	8-14	8-10	8-18	7-31	8-5	8-25	8-26	9-23	Sat	7-18	8-22	8-22	8-22	
5	7-23	6-16	7-1	6-17	6-22	6-29	7-24	7-21	Sun	8-9	9-13	7-19	8-23	
	8-19	8-11	8-21	8-12	8-17	9-9	8-25	8-27	Sat	9-12	9-19	8-22	6-27	
6	6-19	6-17	6-22	6-16	7-1	6-26	6-30	7-20	Sun	8-16	8-23	7-26	6-28	
	7-22	8-12	8-17	8-11	8-21	7-24	9-22	8-27	Sat	6-20	8-29	7-18	8-15	
7	6-24	7-7	6-25	6-29	6-16	7-22	7-21	7-20	Sun	6-21	7-26	7-19	8-30	
	9-3	9-9	8-20	9-10	8-11	9-3	8-24	8-28	Sat	7-18	8-29	7-25	8-1	
8	7-15	6-15	6-16	6-5	6-10	7-16	7-20	7-21	Sun	8-9	9-13	8-23	6-28	
	8-6	8-10	8-11	7-31	8-4	8-31	8-26	9-24	Sat	9-12	9-12	7-18	6-27	
9	6-30	6-5	6-10	6-15	6-25	7-10	6-26	7-23	Sun	7-19	9-20	8-23	9-27	
	8-28	7-31	8-5	8-10	8-20	8-31	8-24	8-21	Sat	8-15	8-22	7-25	8-22	
10	7-2	6-4	6-9	6-3	6-8	7-8	7-1	7-17	Sun	6-14	7-26	8-23	8-30	
	8-27	7-30	8-4	7-29	8-3	9-1	8-28	8-21	Sat	6-13	7-11	7-25	8-29	
11	7-1	6-3	6-8	6-4	6-9	7-9	7-22	7-23	Sun	6/7	8-23	7-19	8-2	
	8-26	7-29	8-3	7-30	9-2	9-1	8-21	9-25	Sat	6-6	7-25	8-22	7-11	
12	7-1	6-1	6-17	7-9	7-10	6-3	6-15	6-16	Sun	5-31	6-14	6-21	6-7	
	8-25	7-27	8-12	9-3	9-2	8-19	8-4	8-3	Sat	8-8	8-22	6-13	6-27	
13	6-24	6-2	6-19	6-1	6-17	6-30	6-23	6-22	Sun	6-7	8-9	6-14	5-31	
	8-26	7-29	8-14	7-27	8-12	7-13	8-31	8-17	Sat	6-27	8-29	6-20	7-11	
14	9-10	7-29	6-18	6-2	6-19	6-29	6-17	6-15	Sun	7-5	8-30	6-21	6-28	
	9-22	9-11	8-13	7-29	8-14	8-17	8-5	8-3	Sat	7-18	6-20	8-1	6-6	
15	8-27	6-15	8-28	6-3	6-18	6-19	6-12	6-17	Sun	6-28	6-14	8-2	7-26	
	9-11	8-3	9-9	7-29	8-13	8-18	8-7	8-5	Sat	6-6	6-20	9-12	7-25	
16	7-16	6-9	6-24	6-8	8-28	7-23	6-16	6-19	Sun	9-13	6-21	8-9	7-19	
	9-8	8-4	8-19	8-3	9-8	7-30	8-6	8-14	Sat	9-12	9-12	8-1	9-19	

ITEM 1

STA. NO.	CLASS. ONLY						INTERVIEW & CLASS		CLASS ONLY	INTERVIEW & CLASS		CLASS ONLY	
	12M-7A	7A-11A	11A-1P	1P-3P	3P-7P	7P-12M	7A-1P	1P-7P	12M-7A	7A-1P	1P-7P	7P-12M	
17	7-17	7-23	6-29	6-9	6-24	6-23	6-19	6-22	Sun	8-30	6-14	8-30	9-13
	9-2	8-6	8-24	8-4	8-19	7-30	8-14	8-17	Sat	6-6	8-29	6-13	9-19
18	7-8	6-26	6-30	6-3	6-29	7-24	6-16	6-12	Sun	7-12	9-20	8-2	8-16
	9-3	9-14	8-25	7-29	8-24	8-5	8-4	8-7	Sat	9-5	6-13	6-20	8-8
19	7-9	6-3	6-9	6-2	7-16	7-20	6-11	6-15	Sun	9-20	8-9	6-21	8-16
	9-4	7-29	9-15	7-28	8-20	8-10	8-4	8-3	Sat	8-8	6-27	8-1	7-18
20	7-10	6-2	7-17	6-1	6-16	7-23	6-23	6-19	Sun	6-21	6-21	9-13	7-26
	9-4	7-28	8-27	7-27	8-5	8-11	9-2	8-14	Sat	7-11	8-22	6-6	7-25
21	7-1	6-1	7-30	6-26	6-30	7-24	6-22	6-11	Sun	5-31	6-14	8-2	7-19
	7-15	7-27	8-5	8-21	8-25	8-4	8-17	8-6	Sat	9-5	9-12	6-20	6-27
22	6-18	7-22	7-16	7-20	7-8	6-25	6-11	6-23	Sun	8-30	8-23	6-7	6-28
	6-30	8-26	8-12	8-17	7-17	8-19	8-6	8-31	Sat	9-12	9-12	8-15	7-18
23	7-8	6-1	6-10	6-2	6-11	8-7	7-7	7-10	Sun	5-31	6-14	7-12	8-23
	9-4	7-27	8-5	7-28	8-6	9-9	8-13	9-1	Sat	6-6	6-13	8-15	6-13
24	7-9	6-2	6-11	6-1	7-22	7-14	7-8	7-13	Sun	6/7	6-28	7-12	8-9
	9-3	7-28	9-16	7-27	8-5	9-8	9-1	8-13	Sat	9-12	7-11	8-15	6-20
25	7-17	6-3	6-12	6-15	6-23	6-24	7-10	7-13	Sun	7-26	6-14	7-12	9-13
	9-11	7-29	8-7	8-10	8-18	8-19	9-1	8-13	Sat	6-20	9-19	8-8	8-1
26	7-17	6-15	6-23	6-3	6-12	6-30	7-13	7-10	Sun	6-21	6-28	8-16	6-14
	9-21	8-10	8-18	7-29	8-7	8-26	9-4	9-2	Sat	7-25	8-1	7-11	8-8
27	7-21	6-16	7-31	8-14	6-22	7-1	9-4	7-6	Sun	7-19	7-12	8-16	8-16
	9-15	8-11	8-27	9-15	8-17	8-28	9-10	9-2	Sat	7-18	6-27	7-11	8-15
28	6-29	8-14	6-22	6-16	6-17	7-13	8-31	7-6	Sun	7-26	8-2	9-13	8-16
	9-16	9-14	8-17	8-11	8-12	7-21	9-11	9-3	Sat	7-25	6-27	7-11	8-15
29	7-20	7-22	6-17	6-1	7-31	7-20	6-30	7-6	Sun	7-19	8-23	8-1	8-
	9-17	9-15	8-12	9-14	8-27	9-8	9-3	9-9	Sat	7-18	7-11	9-26	8-8
30	7-20	6-15	6-16	6-3	6-12	7-22	7-8	6-30	Sun	6-21	7-12	9-13	8-30
	8-26	8-10	8-11	7-29	8-7	9-9	9-10	9-3	Sat	7-18	8-1	6-27	8-22
31	6-22	6-3	6-12	6-15	6-16	7-21	6-29	7-1	Sun	6-7	7-19	6-28	6-14
	9-19	7-29	8-7	8-10	8-11	8-28	9-4	9-10	Sat	9-19	8-1	9-12	8-29
32	6-23	6-2	6-11	6-1	6-10	7-14	7-7	6-29	Sun	5-31	8-2	6-28	9-13
	8-20	7-28	8-6	7-27	8-5	8-27	9-9	9-11	Sat	6-6	8-22	9-12	6-13
33	6-24	6-1	6-10	6-3	6-11	7-15	7-1	9-9	Sun	6-7	6-14	9-13	5-31
	8-	7-27	8-5	7-28	8-6	9-10	9-11	8-25	Sat	6-6	9-19	6-27	6-13

AVERAGE TRAFFIC

AVERAGE MACHINE COUNT / DAY (AMC)

<u>STATION</u>	<u>AMC</u>	<u>STATION</u>	<u>AMC</u>	<u>STATION</u>	<u>AMC</u>
1	3497	12	5969	23	1119
2	163	13	8635	24	326
3	837	14	6942	25	4272
4	219	15	13426	26	2654
5	297	16	2071	27	1937
6	1225	17	2381	28	1468
7	2479	18	10017	29	3226
8	2003	19	1034	30	3407
9	2152	20	965	31	10097
10	751	21	554	32	9932
11	6983	22	938	33	7492

AVERAGE MACHINE COUNT / DAY / STATION FOR

Upper Peninsula	1,873
Lower Peninsula	4,535
TOTAL	3,648

RATIO OF TRAFFIC TO MACHINE COUNTS FOR

Upper Peninsula	0.9590
Lower Peninsula	0.9526
TOTAL	0.9538

AVERAGE TRAFFIC / DAY / STATION FOR

Upper Peninsula	1,796
Lower Peninsula	4,320
TOTAL	3,479

TRAFFIC FOR ENTIRE FOUR MONTH PERIOD FOR

Upper Peninsula	2,435,400
Lower Peninsula	11,665,566
TOTAL	14,100,966

Item 3

ESTIMATING THE TOTAL GALLONS OF GAS BOUGHT AND
USED IN MICHIGAN BY OUT-STATE BOATS.

Let R be the ratio estimate of gas to boats and S be the ratio estimate of boats to traffic. Let \overline{SS} be the estimate of the standard deviation of boats to traffic and \overline{RS} be the estimate of the standard deviation of gas to traffic. Let T be the estimate of traffic for the four month period. Then the estimate of the total gallons of gas, K, is given by the formula:

$$K = R \times S \times T$$

with a standard deviation, \overline{KK} , given by the formula:

$$\overline{KK} = \overline{RS} \times T$$

The estimate of the total number of out-state boats, J, is given by the formula:

$$J = S \times T$$

with a standard deviation, \overline{JJ} , given by the formula:

$$\overline{JJ} = \overline{SS} \times T$$

Finally, 90% confidence intervals for K and J are obtained by the formulae:

$$(K - 3\overline{KK}, K + 3\overline{KK}) \text{ and}$$

$$(J - 3\overline{JJ}, J + 3\overline{JJ})$$

The data from the study yielded the following values:

	UPPER PENINSULA	LOWER PENINSULA	TOTAL
R	4.45970	7.65337	6.95774
S	0.00753	0.00454	0.00507
\overline{RS}	0.00704	0.00899	0.00749
\overline{SS}	0.00060	0.00039	0.00033
T	2,435,400	11,665,566	14,100,966
K	81781	405262	497341
\overline{KK}	17145	104873	105616
J	18339	52962	71492
\overline{JJ}	1461	4550	4653

Item 4

SOME REMARKS ON TERMINOLOGY

When looking at the results in Chapter IV, it is apparent that the individual estimates for the Lower Peninsula and the Upper Peninsula do not add up to the estimate derived for the entire state. However, this is not unreasonable when using ratio estimates. For example, if 10 boats are observed in a sample of 100 units of traffic in the Lower Peninsula and it is estimated that there was actually 10,000 units of traffic in the Lower Peninsula, it would be estimated that the total number of boats for the Lower Peninsula was 10% of 10,000 or 1,000. Now if 10 boats are observed in a sample of 50 units of traffic in the Upper Peninsula and it is estimated that there was actually 1,000 units of traffic in the Upper Peninsula, then the estimate of the total number of boats for the Upper Peninsula would be 20% of 1,000 or 200. Then for the entire state, 20 boats in a sample of 150 units of traffic have been observed and it is estimated that there are actually 11,000 units of traffic for the entire state. Hence one would estimate the total number of boats for the entire state to be 13.33% of 11,000 or 1,467. But the sum of the estimates for the Upper and Lower Peninsula is 1,200.

Some remarks are in order in mentioning confidence intervals. When attempting to estimate some parameter, a single point estimate is usually derived. However, this is somewhat unsatisfactory since the point estimate is almost surely wrong even though it may be very near the true value

Item 4
(continued)

of the parameter. Consequently attempts are made to place bounds on the error of the estimate in order to interpret the accuracy of this point estimate. Upon determining these bounds, the estimate for the parameter is given by an interval based on these bounds and the point estimate. Such an interval is then labeled as a confidence interval after determining the confidence on the bounds of the error of the estimate.

It is known in probability theory due to a famous result known as the Chebychev Theorem that if $\hat{\sigma}$ is used as a point estimate for some parameter σ and if the standard deviation of $\hat{\sigma}$ is given by $s(\hat{\sigma})$, then for any number d , $P[|\hat{\sigma} - \sigma| \leq ds(\hat{\sigma})] \geq 1 - (1/d)^2$. This result holds no matter what the distribution of $\hat{\sigma}$ may be. Of course, if the exact distribution of $\hat{\sigma}$ is known, the value of this probability may be determined exactly. The beauty of this result above is that a lower bound can be found for this probability regardless of the distribution of $\hat{\sigma}$. Letting $d = 3$, it can be seen that $P[|\hat{\sigma} - \sigma| \leq 3s(\hat{\sigma})] \geq 1 - \frac{1}{9} = 8/9$. Now $P[|\hat{\sigma} - \sigma| \leq 3s(\hat{\sigma})] = P[\sigma \in (\hat{\sigma} - 3s(\hat{\sigma}), \hat{\sigma} + 3s(\hat{\sigma}))]$. Hence, $P[\sigma \in (\hat{\sigma} - 3s(\hat{\sigma}), \hat{\sigma} + 3s(\hat{\sigma}))]$ is greater than or equal to .889. So an interval estimate for σ given by $(\hat{\sigma} - 3s(\hat{\sigma}), \hat{\sigma} + 3s(\hat{\sigma}))$ would be called a confidence interval for σ with a confidence of at least 88.9%. Consulting Appendix B, it can be seen that this is the type of interval estimate generated in the study. Since these intervals have a confidence of at least 88.9%, they are called 90% confidence intervals without very much loss of generality.

<p>LIBRARY michigan department of state highways LANSING</p>
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Item 4
(continued)

A few remarks are still in order here. If, for example, the 90% confidence interval on the number of boats in the Upper Peninsula is said to be (13,955, 22,722) it is not meant that the actual number of boats is between 13,955 and 22,722 with probability .90. The number of boats in the Upper Peninsula is a fixed number and is either between 13,955 and 22,722 or it is not. What is meant is that the procedure used to generate the interval (13,955, 22,722) is 90% accurate. In other words, if the sampling procedure were repeated a large number of times and a new interval calculated in the same manner for each of the samples, approximately 90% of all these intervals would contain the true value of the number of boats in the Upper Peninsula.

Appendix C (Segment 3)

- Item 1 - Marina survey questionnaire
- Item 2 - Map of lakeshore survey locations
- Item 3 - Interpolation of partial marina survey data

MICHIGAN MARINA STUDY

- PLEASE INDICATE THE CORRECT NAME AND ADDRESS OF THIS MARINA AND NAME OF THE OPERATOR OR MANAGER.

Marina Name _____

Address _____

_____ Zip Code

Operator or Manager's Name _____

Telephone Number _____
Area Code Telephone Number

- DO YOU SELL GASOLINE FOR BOATS? Yes No

- DO YOU SELL DIESEL FUEL FOR BOATS? Yes No

- IF YOU SELL BOATING FUEL, WHAT IS THE NAME AND ADDRESS OF YOUR FUEL WHOLESALER?

Name _____

Address _____

_____ Zip Code

- PLEASE INDICATE THE APPROXIMATE MAGNITUDE OF THE SERVICES YOU HAVE AVAILABLE.

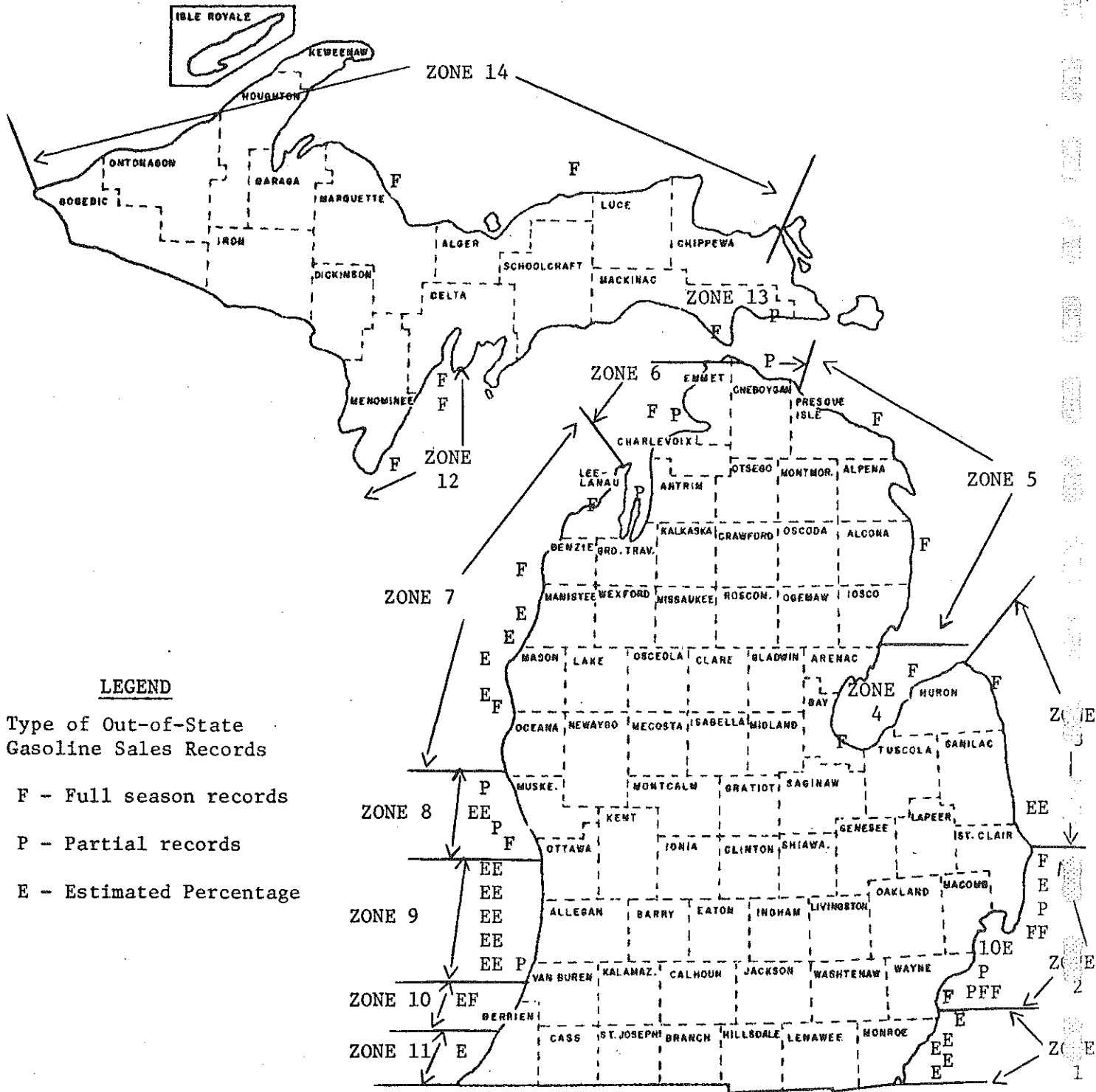
No. of Boat Wells _____ No. of Mooring Buoys _____

- APPROXIMATELY HOW MUCH OF YOUR BUSINESS IS FROM OUT-OF-STATE BOATERS?

Most	<input type="checkbox"/>	Very Little	<input type="checkbox"/>
More Than Half	<input type="checkbox"/>	None	<input type="checkbox"/>
Less Than Half	<input type="checkbox"/>		

- ANY ADDITIONAL COMMENTS? _____

Please return this questionnaire to the Recreation Research and Planning Unit, Department of Park and Recreation Resources, Room 131 Natural Resources Building, Michigan State University, East Lansing, Michigan 48823.



Map of Michigan Showing Distribution of Types of Marina Sales Records and Sales Zones

INTERPOLATION OF SEASONAL PARTIAL DATA TO GIVE ESTIMATES OF TOTAL
SALES TO OUT-OF-STATE BOATS DURING THE ENTIRE SEASONMarina
Number

- 53 - Record for August only.
Recorded 81.2 gallons = 44% of total out-of-state gallons.¹
Total out-of-state gallons = 184.
- 73 - Record for 10 days in July only.
Recorded 517 gallons x 3 = 1551 gallons for July.
1551 gallons = 50% of total out-of-state gallons.
Total gallons sold out-of-state = 3102.
- 123 - Record 1 week in July only.
Recorded 20.3 gallons x 4 = 81.2 gallons for July.
162 gallons = 50% of total out-of-state gallons.
Total out-of-state gallons = 162.
- 197 - Record for 1 week in July only.
Recorded 435.3 gallons x 4 = 1741.2 gallons for July.
1741.2 gallons = 50% of total out-of-state gallons.
Total out-of-state gallons = 3482.
- 333 - Record for June and 2 weeks in July only.
Recorded (June) 479 + (July) (684 x 2) = 1847 gallons
for June and July.
1847 gallons = 52% of total out-of-state gallons.
Total out-of-state gallons = 3552.
- 367 - Record for July only.
Recorded 485 gallons = 50% of total out-of-state gallons.
Total out-of-state gallons = 970.
- 388 - Record for June and July only.
Recorded 970 gallons = 52% of total out-of-state gallons.
Total out-of-state gallons = 1865.
- 442 - Record for 2 weeks of July only.
Recorded 253 gallons x 2 = 506 gallons for July.
506 = 50% of total out-of-state gallons.
Total out-of-state gallons = 1012.

Item 3
(continued)Marina
Number

- 462 - Record for June and 2 weeks of July only.
Recorded (June) 158.9 gallons + July (283.1 x 2) = 725.1
gallons for June and July.
725.1 = 52% of total out-of-state gallons.
Total out-of-state gallons = 1394.
- 481.1 - Record for June only.
Recorded 330 gallons = 2% of total out-of-state gallons.
Total out-of-state gallons = 16,500.
- 500.1 - Record for 10 days in July only.
Recorded 644 gallons x 3 = 1932 gallons for July.
1932 gallons = 50% of total out-of-state gallons.
Total out-of-state gallons = 3864.

Appendix D (Segment 4)

Item 1 - Survey interview questions

Item 2 - Liveries in Lake St. Clair area

Item 1

Hello,

I'm _____ from the Department of State
Highways.

We are doing a Marine Fuel Study by request of the Department
of Natural Resources, Department of Roads, and U.S. Bureau of Public
Roads.

Rather than sending you an advance letter we are contacting
boat owners by phone or personal contact.

May I please ask you a few questions?

Thank You Very Much!

MICHIGAN MARINE FUEL STUDY
QUESTIONNAIRE

(* Registration number
of one boat belonging
to this owner)

LIVERY QUESTIONNAIRE

6870AR*
John Boatowner 14 Apple Drive Muskegon, Michigan 49441

Phone _____

Date Called _____

Remarks _____

Call-Back Date _____

- Are you the owner of the above boat? Yes No
- Number of boats registered to this owner:

Propulsion/ Type / ft.	0-11.99	12-19.99	20-29.99	30-39.99	40+
Inboard					
Outboard					
Sail/Aux.					

- Total number of gallons of gasoline purchased in Michigan (October 1, 1969 - September 30, 1970) for a typical boat in each category:

	0-11.99	12-19.99	20-29.99	30-39.99	40+
Inboard					
Outboard					
Sail/Aux.					

- Average horsepower of motors used on a typical boat in each category:

	0-11.99	12-19.99	20-29.99	30-39.99	40+
Inboard					
Outboard					
Sail/Aux.					

Item 2

Liveries in the Lake St. Clair Area

In view of the fishing ban, a few remarks about the Lake St. Clair area are in order. The term "Lake St. Clair Area" is defined as those counties which contain shoreline of Lake St. Clair: St. Clair, Macomb, Oakland, and Wayne. In terms of the study data, this encompasses 34 owners and a total of 454 boats. All but six of the boats fall into the propulsion-length category of "Outboard 12-19.99 ft.," so remarks will be confined to members of this category.

Of these 34 owners, 19 reported using no gasoline in their boats. Only four of the nineteen made specific mention of the fishing ban in explanation; others either gave no reason for zero use or explained that they owned no rental motors. These nineteen "zero-use" owners accounted for 269 of the 448 boats in this propulsion-length category.

The details of the analysis for Lake St. Clair liveries are as follows:

N = number of boats = 448

n = number of owners = 34

G = total number of gallons of taxable gasoline consumed = 4,106

\bar{G} = average consumption per boat = 9.17 gallons

s.d. (\bar{G}) = standard deviation of \bar{G} = 2.55 gallons

It is interesting to compare 95% confidence intervals on the true mean consumption for Lake St. Clair with the corresponding intervals for the state as a whole. The two-sided 95% confidence interval on the mean for

Item 2
(continued)

Lake St. Clair is (4.17, 14.17), whereas the two-sided interval for the entire state is (16.04, 19.39). Thus, the mean gasoline consumption per boat appears to be significantly lower in Lake St. Clair than in the state as a whole.

On the other hand, if only the upper limits on the average consumption are considered, the differences are not so noticeable. This is due mainly to the fact that consumption per boat is more variable in the Lake St. Clair area than in the whole state -- a standard deviation of 2.55 gallons for Lake St. Clair, as compared to 0.86 gallons overall. Thus the 95% upper confidence limits on the mean consumption per boat are 15.69 for Lake St. Claire and 19.94 for the entire state.

Appendix E (Segment 5)

- Item 1 - Survey letter
- Item 2 - Survey questionnaire
- Item 3 - Follow-up letter

STATE OF MICHIGAN



WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

RALPH A. MAC MULLAN, Director

NATURAL RESOURCES COMMISSION

E. M. LAITALA
Chairman
CARL T. JOHNSON
ROBERT C. McLAUGHLIN
AUGUST SCHOLLE
HARRY H. WHITELEY

WATERWAYS COMMISSION

VOLMAR J. MILLER
Chairman
ROBERT F. KING
Vice Chairman
LEONARD H. THOMSON
Secretary
CHARLES A. BOYER
ARTHUR G. ELLIOTT

Stevens T. Mason Building
Lansing, Michigan 48926
373-0626

TO ALL DOCUMENTED BOAT OWNERS:

A marine fuel consumption study is being jointly sponsored by the Michigan Department of State Highways and the Michigan State Waterways Commission.

The purpose of this study is to determine what percentage of all gasoline consumed in Michigan is attributable to recreational watercraft.

Will you please help us in this study by keeping records of the total amount of gas purchased this boating season and your estimate of last years gas purchases using the enclosed forms. The forms should be returned in October with the reply envelope provided.

Your assistance in making Michigan's boating industry an even greater attraction is deeply appreciated.

Sincerely,


Keith Wilson
Director

KW/jmk

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

DOCUMENTED BOAT
QUESTIONNAIRE

DO YOU STILL OWN THIS VESSEL?

YES NO

WHAT IS THE HORSEPOWER RATING OF YOUR MOTOR(S)?

_____ H.P. _____ H.P.

GASOLINE RECORD

Please keep a record of your monthly gas purchases for this boating season and an estimate of last years.

	1969 ESTIMATED GALLONS	1970 ACTUAL GALLONS
JAN-MAY		
JUN		
JUL		
AUG		
SEP		
OCT-DEC		

STATE OF MICHIGAN



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Vice Chairman
LEONARD H. THOMSON
Secretary
CHARLES A. BOYER
ARTHUR G. ELLIOTT
Stevens T. Mason Building
Lansing, Michigan 48926
373-0626

TO ALL DOCUMENTED BOAT OWNERS:

This is a reminder mailing to ask you to complete the gasoline record which was sent to you earlier this summer for your documented boat. In case you have misplaced the earlier form, we have enclosed a second copy.

The purpose of this study is to determine what percentage of all gasoline sold in Michigan is attributable to recreational watercraft. If you have not filled out the previous form because you have sold your boat or for some other reason, please write a short comment on the form and mail it in.

Your assistance in making Michigan's boating industry an even greater attraction is greatly appreciated.

Sincerely,

Keith Wilson
Director

KW/MF/jmk

