STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-35-R-23

Study No.: 667 **Title:** Redesign of sportfishing creel surveys

Period Covered: April 1, 1997 to March 31, 1998

Study Objective: Determine which method, or methods, for calculating catch per hour are appropriate for use with Michigan creel surveys. Prepare sampling scheme for total catch and angling pressure for the sportfishery in Michigan waters of Lake Michigan.

Summary: Lake Michigan angler survey methods currently use access site methods as described by Fabrizio et al. (1991). Four different sampling or clerk allocation techniques were evaluated to improve efficiency of this survey. Techniques were: (1) determine site-to-site relationships of angling effort at six southern Lake Michigan sampling sites; (2) optimal allocation of clerk effort; (3) proportional allocation of clerk effort; and (4) bus route design. Efficiency would be improved if a technique or techniques resulted in a reduction in number of clerks or cost, or an improvement in accuracy and precision of angling estimates.

Job 4. Title: Assemble Lake Michigan creel data sets.

Findings: Lake Michigan count and interview data sets were assembled for years 1985-96. Data were read into dBase IV files and each resulting file contained count or interview data for a single year. Individual records were specific by site (Figure 1), month, day and fishing mode. Maximum annual sampling periods were April 1 through October 31, with seasonal sites covering an abbreviated season. Angler interviews were by angling party and all catch information was harvest by species. A salmon category was established for each interview record and represented the sum of lake trout, brown trout, chinook salmon, coho salmon, steelhead salmon and pink salmon harvested by a given angling party.

Job 5. Title: Develop and evaluate sampling methods.

Findings: Sampling methods evaluated were: linear regression relationships of boats counted; optimum allocation of clerk effort; proportional allocation of clerk effort; and bus route design.

Linear regression relations¾ Linear regression relationships were estimated for boat counts within sites in statistical district MM-8 for period 1986-94 (Table 1). Potential relationships would result in reduction of number of survey clerks needed to conduct Lake Michigan angler survey. Only boat counts were used and all counts in MM-8 were interval type (Lockwood et al., in press). Count duration was 0.25 h during first years and 0.50 h during latter years. To evaluate on count per minute basis, individual counts were divided by count duration for that count. Only counts with matching dates and times were used and periods were stratified by day-type (week day or weekend day) within a month. Relationships were considered significant when slope$\neq$0.0 at α=0.05.

The relationship between sites was significant for only 6 of 68 comparisons. No trends were noted and this method was not considered a reasonable alternative to current access count methods.

Optimal allocation of clerk effort¾ Optimal allocation of clerk effort within statistical district MM-8 for periods April 1 through October 31 was determined. This method can potentially improve accuracy and precision of the Lake Michigan survey. Allocation was based on interval boat count data 1985-95. To compare counts on a per minute basis, individual counts were divided by count duration for that count. Count rates were then averaged per day with mean daily counts averaged over entire period. Optimal allocation of clerk effort at site *p* within a statistical district having *h* sites follows Cochran (1977) as:

$$C_i \bullet \frac{\overline{N}_{pi} SD_{\overline{N}_{pi}}}{\sum_{k=1}^{h} \sum_{j=1}^{m} \overline{N}_{kji} SD_{\overline{N}_{kji}}}, \qquad (1)$$

where, *C* is the number of clerk days available during period *i* with *m* counts having mean $\overline{N}$ and standard deviation *SD*. Results are given in Table 2.

Optimal allocation of clerk effort places emphasis on both sample mean and variability (standard deviation) around that mean. One of the goals of this study was to improve the accuracy of lake-wide angling estimates. Hence, optimal allocation was considered inappropriate for this purpose since lesser used ports (smaller sample means) with greater variability were allocated more clerk effort (more days sampled).

Proportional allocation of clerk effort¾ Allocation of clerk effort was based on boat counts; and boat angler catch-per-hour of salmon, yellow perch and walleye. All interviews were for completed trips and catch per hour was calculated using ratio-of-means estimator (Lockwood 1997, Jones et al. 1995). Evaluation was done for 29 sampling sites within the 8 statistical districts. Minimum sampling effort (clerk days) for any site was 2 days per time period. Allocation of effort is based on 10 clerks and represents number of clerks used historically to cover all 29 sites (G.Rakoczy, personal communication). Maximum sampling period was April 1 to October 31 with some seasonal sites covering a shorter period. Results are given in Tables 3-10 and each monthly sampling schedule is based on 12 week days and 8 weekend days of sampling effort per clerk. Proportional allocation of effort was calculated as (Cochran 1977):

$$C_i \bullet \frac{\overline{N}_{pi}}{\sum_{j=1}^{m} \overline{N}_{ji}}. \qquad (2)$$

Proportional allocation of clerk effort provided satisfactory sampling design for 5 of 8 statistical districts (Table 11). Sampling schedule was considered satisfactory when allocation of clerk effort, based on boat counts or catch rates from any of the 3 species groups, was similar. Given that angling effort varies between ports, greater sampling effort of larger more frequently used ports (greater sample means) potentially furthers the study goal of improved accuracy of lake-wide angling estimates.

The proportional allocation method resulted in reallocation of clerk effort in statistical districts MM-2, MM-4 and MM-7. Proportional allocation was not different from equal allocation in statistical districts MM-3 and MM-5. Contradictory sampling schedules resulted in statistical districts MM-1, MM-6 and MM-8.

Contradictory allocation of clerk effort was due to allocation differences in one or more of the catch rates from boat counts. This often appeared due to capacity of the site. Sites large enough to accommodate many boats typically have greater mean boat counts than smaller sites which accommodated fewer boats. However, catch rates do not necessarily follow this same pattern. When catch rates were greater at smaller sites with fewer boats counted, inconsistent allocation of clerk effort was suggested. Allocation of clerk effort based on angling effort and catch rates does not appear to be a satisfactory alternative to the current method of equal allocation.

Bus route design¾ This method was appraised for potential reduction in number of clerks. Detailed descriptions of bus route design are given by Jones and Robson (1991) and Pollock et al. (1994). Lake Michigan angler survey area was driven with distance and driving time between sites recorded. Three survey clerk coverage areas were established based on distance between sites. Sites 1 through 48 in statistical district MM-1 and MM-2 were one coverage area; sites 80 to 100 in MM-3 and MM-4 were the second; and sites 116 to 166 in MM-5 through MM-8 the third. Minimum wait time at each site was ≥1.0 h (Jones and Robson 1991). Site locations along Lake Michigan are given in Figure 1; and a bus route schedule with distances, drive times and wait times given in Tables 12-14. Number of clerks needed for this method was adjusted by wait time per site and driving time between sites for each coverage area.

Total number of clerks needed for Lake Michigan angler survey was reduced from 10 to 8 clerks using the bus route design. Minimum wait time per site varied from 1.16 to 2.90 h. Mean distance between sites was 23.4 ±11.5 miles (1 SD) and mean driving time between sites was 39.7 ±17.0 min (1 SD). Minimum total distance driven per day by all 8 clerks was 841.6 miles and accounts for round trip mileage, by individual clerks, from first port sampled to last port sampled and return to first port. Minimum daily mileage cost, based on $0.24 per mile, was $201.98.

Salary savings from reduction of 2 clerks using this method is more than offset by the additional mileage cost. Based on an 8 h day, minimum hourly travel expense for 8 clerks is $25.25. On sample days when scheduled sampling order calls for sampling a site furthest from a clerk's home base first, additional mileage is incurred. Consider the following examples. Assume mileage is paid from a base site for a given clerk. In these examples the base site is site 1&7. If the schedule calls for a clerk to sample sites 1&7, 15 and 18 in that order; the clerk would drive a total of 51.4 miles one way (102.8 miles round trip at a cost of $24.67). If instead, the scheduled called for sampling sites 18, 1&7 and 15 in that order; the clerk would drive 51.4 miles to site 18, 51.4 miles back to sites 1&7, 29.4 miles to site 15 and then 29.4 miles back to base. Total distance driven is 161.6 miles at a cost of $38.78. In the first example, wait time at each site would be 1.81 h, in the second example wait time at each site would be 1.26 h. Additional mileage costs associated with this method make it impractical.

Recommendations¾ The maximum number of sites sampled occurred in 1985 (Fabrizio et al. 1991). The ratio, based on 1985 estimates, of all sites to current year sites sampled is used to approximate lake wide estimates. Relationship between these sites has not been evaluated since 1985. Based on methods considered in this study, current access site survey methods using equal sampling at all sites are appropriate. However, expansion ratios for unsampled sites based on 1985 data should be updated. Unsampled sites within statistical districts should be resampled on

a regular basis. A recommendation of this study is a 3-year update time frame. Reliability of these ratios and resulting estimates of angling activity will be greatly enhanced.

Literature Cited:

Cochran, W. G. 1977. Sampling techniques. John Wiley and Sons, Inc., New York, New York.

Fabrizio, M. C., J. R. Ryckman, and R. N. Lockwood. 1991. Evaluation of sampling methodologies of the Lake Michigan creel survey. American Fisheries Society Symposium 12:162-176.

Jones, C. M., D. S. Robson, H. D. Lakkis, and J. Kressel. 1995. Properties of catch rates used in analysis of angler surveys. Transactions of the American Fisheries Society 124:911-928.

Jones, C. M. and D. S. Robson. 1991. Improving precision in angler surveys: traditional access design versus bus route design. American Fisheries Society Symposium 12:177-188.

Lockwood, R. N., D. M. Benjamin, and J. R. Bence. In press. Estimating angling effort and catch from Michigan roving and access site angler survey data. Michigan Department of Natural Resources, Fisheries Research Report 2044, Ann Arbor, Michigan.

Lockwood, R. N. 1997. Evaluation of catch rate estimators from Michigan access point angler surveys. North American Journal of Fisheries Management 17:611-620.

Pollock, K. H., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society Special Publication 25.

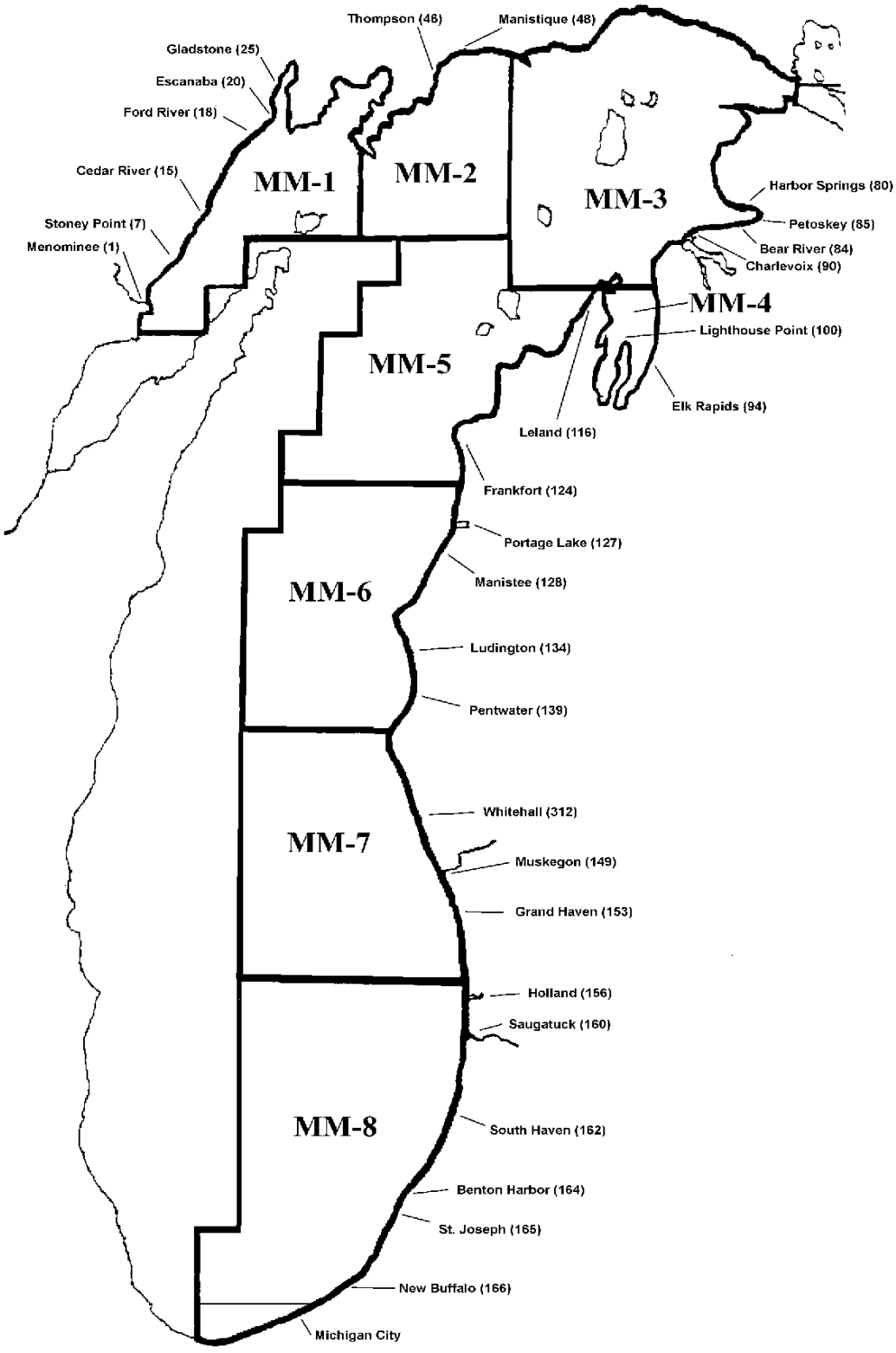

Figure 1.—Statistical districts MM-1 through MM-8 and angler survey ports (site codes in parenthesis) along the Michigan waters of Lake Michigan.

Table 1—Coefficients of determination of linear relationships for six Lake Michigan sites, 1986-94, in statistical district MM-8. Data values are based on monthly mean interval counts for each year. Monthly means are weighted by count duration. Significant relationships (slope ≠0.00) at α=0.05 are noted with an "*". Site codes are shown in Figure 1. Column headers give regression variables (sites) as: independent—>dependent.

Month/ day of week	162—>156	162—>166	164—>156	166—>156	156—>160
April week days	0.06	0.08	<0.01	0.02	-
April weekend days	0.06	0.10	0.01	0.38	-
May week days	0.46	0.19	0.22	0.19	0.13
May weekend days	<0.01	0.13	0.01	0.48	0.01
June week days	0.17	0.03	0.04	0.07	0.91*
June weekend days	0.07	0.16	0.23	0.25	0.02
July week days	0.26	0.76*	0.72*	0.22	0.32
July weekend days	0.91*	0.01	<0.01	0.01	1.00*
August week days	0.68	0.24	0.14	0.09	0.28
August weekend days	0.44	<0.01	0.09	0.09	0.06
September week days	0.14	0.23	0.09	0.16	0.49
September weekend days	<0.01	<0.01	0.08	0.21	0.67
October week days	0.01	0.02	0.65*	0.32	0.08
October weekend days	0.37	0.09	<0.01	0.06	0.01

Table 2.—Optimal allocation of clerk effort based on 1985-95 interval boat counts in Lake Michigan statistical district MM-8. Allocation assumes 2 clerks working 24 week days and 16 weekend days each month. Practical allocation rounds calculated effort to whole days and allows for a minimum of 2 days sampled per site.

	Week days					Weekend days				
Month/ Site	Mean Count	S^2	n	Calculated allocation	Practical allocation	Mean Count	S^2	n	Calculated allocation	Practical allocation
April										
156	0.0193	0.0004	24	0.6	2	0.0409	0.0017	17	0.2	2
160	0.0278	0.0024	3	2.1	3	0.1764	0.0171	4	2.8	3
162	0.0877	0.0132	29	15.6	12	0.2040	0.1048	21	8.1	6
164	0.0470	0.0026	40	3.7	4	0.1783	0.0243	31	3.4	3
166	0.0340	0.0014	46	2.0	3	0.0984	0.0162	43	1.5	2
May										
156	0.0546	0.0023	34	2.8	3	0.1217	0.0232	22	1.5	2
160	0.0377	0.0007	9	1.1	2	0.3605	0.0642	9	7.4	7
162	0.0940	0.0207	28	14.6	14	0.1385	0.0289	26	1.9	2
164	0.0531	0.0035	43	3.4	3	0.2044	0.0217	34	2.5	2
166	0.0385	0.0027	46	2.2	2	0.1569	0.0445	45	2.7	3
June										
156	0.0507	0.0028	37	3.7	4	0.1378	0.0497	28	3.3	3
160	0.0787	0.0071	12	9.3	8	0.2139	0.0406	10	4.6	4
162	0.0552	0.0036	42	4.6	5	0.1481	0.0092	25	1.5	2
164	0.0510	0.0029	37	3.8	4	0.2108	0.0154	33	2.8	3
166	0.0364	0.0027	55	2.6	3	0.1329	0.0738	40	3.8	4
July										
156	0.1044	0.0174	36	4.0	4	0.1915	0.0808	26	2.5	2
160	0.2495	0.0344	12	13.5	11	0.3546	0.1647	6	6.6	7
162	0.1144	0.0074	39	2.9	3	0.3057	0.0403	28	2.8	3
164	0.0759	0.0069	38	1.8	3	0.2407	0.0480	36	2.4	2
166	0.0733	0.0067	45	1.8	3	0.1937	0.0327	42	1.6	2
August										
156	0.0915	0.0100	40	4.5	4	0.1022	0.0061	24	0.4	2
160	0.1648	0.0210	9	11.7	11	0.4229	0.2443	8	11.0	8
162	0.0896	0.0108	33	4.6	5	0.1439	0.0203	30	1.1	2
164	0.0747	0.0036	43	2.2	2	0.2330	0.0113	31	1.3	2
166	0.0386	0.0027	51	1.0	2	0.1699	0.0598	42	2.2	2
September										
156	0.0389	0.0087	38	12.3	10	0.1070	0.0118	21	2.2	2
160	0.0167	0.0023	6	2.7	3	0.2000	0.0315	5	6.8	6
162	0.0289	0.0024	37	4.8	5	0.1273	0.0173	25	3.2	3
164	0.0239	0.0020	43	3.6	4	0.1059	0.0190	35	2.8	3
166	0.0090	0.0003	41	0.5	2	0.0799	0.0046	35	1.0	2
October										
156	0.0129	0.0001	32	4.7	5	0.0199	0.0011	21	3.6	3
160	0.0083	0.0003	4	4.2	4	0.0083	0.0008	6	1.3	2
162	0.0119	0.0003	34	6.3	6	0.0245	0.0015	27	5.2	5
164	0.0047	0.0002	36	1.9	2	0.0173	0.0009	34	2.8	3
166	0.0091	0.0006	44	6.9	7	0.0206	0.0007	37	3.1	3

Table 3.—Proportional sampling schedule for statistical district MM-1 based on instantaneous boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are based on 2 clerks. Section A is sites 1&7,15 and Section B sites 18,20,25. Either section A or Section B is worked during one clerk day. Sampling schedules are based on 1985-95 data and 1994-96 data.

	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Week days														
1985-95														
Boats	4	20	4	20	5	19	7	17	4	20	4	20	4	20
SAL	20	4	20	4	20	4	20	4	20	4	20	4	4	20
YEP	4	20	4	20	20	4	17	7	14	10	10	14	4	20
WAE	20	4	4	20	4	20	4	20	4	20	4	20	12	12
1994-96														
Boats	4	20	4	20	4	20	4	20	4	20	4	20	4	20
SAL	20	4	20	4	20	4	20	4	20	4	20	4	4	20
YEP	4	20	4	20	20	4	20	4	20	4	16	8	4	20
WAE	20	4	4	20	16	8	4	20	4	20	4	20	12	12
Weekend days														
1985-95														
Boats	4	12	4	12	4	12	4	12	4	12	4	12	4	12
SAL	12	4	12	4	12	4	12	4	12	4	12	4	8	8
YEP	4	12	4	12	12	4	10	6	11	5	10	6	4	12
WAE	12	4	4	12	4	12	4	12	4	12	4	12	4	12
1994-96														
Boats	4	12	4	12	4	12	4	12	4	12	4	12	4	12
SAL	12	4	12	4	12	4	12	4	12	4	12	4	8	8
YEP	4	12	4	12	12	4	12	4	11	5	12	4	4	12
WAE	12	4	4	12	9	7	4	12	4	12	4	12	4	12

Table 4.—Proportional sampling schedule for statistical district MM-2 based on instantaneous boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are based on 1 seasonal clerk. Sampling schedules are based on 1985-89 (last sampled in 1989).

	Jul.		Aug.		Sep.		Oct.	
	46	48	46	48	46	48	46	48
Week day								
1985-89								
Boats	4	8	4	8	4	8	4	8
SAL	4	8	4	8	4	8	5	7
YEP	4	8	4	8	6	6	6	6
WAE	4	8	4	8	4	8	6	6
Weekend day								
1985-89								
Boats	2	6	2	6	2	6	2	6
SAL	2	6	2	6	2	6	3	5
YEP	2	6	2	6	4	4	4	4
WAE	2	6	2	6	2	6	4	4

Table 5.— Proportional sampling schedule for statistical district MM-3 based on instantaneous boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1 clerk. Section A is sites 80,84,85 and Section B site 90. Either section A or Section B is worked during one clerk day. Sampling schedules are based on 1985-95 data and 1994-96 data. Periods where data are not available are denoted with "-".

	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Week day														
1985-95														
Boats	8	4	8	4	7	5	6	6	6	6	6	6	7	5
SAL	6	6	4	8	6	6	5	7	6	6	5	7	7	5
YEP	6	6	8	4	8	4	8	4	8	4	8	4	8	4
WAE	6	6	6	6	6	6	6	6	6	6	6	6	6	6
1994-96														
Boats	-	-	7	5	7	5	6	6	6	6	5	7	-	-
SAL	-	-	3	9	7	5	5	7	6	6	8	4	-	-
YEP	-	-	8	4	6	6	6	6	8	4	8	4	-	-
WAE	-	-	6	6	6	6	6	6	6	6	6	6	-	-
Weekend days														
1985-95														
Boats	6	2	5	3	4	4	3	5	3	5	3	5	4	4
SAL	4	4	4	4	5	3	4	4	4	4	2	6	4	4
YEP	4	4	4	4	6	2	6	2	6	2	6	2	4	4
WAE	4	4	4	4	4	4	2	6	2	6	4	4	4	4
1994-96														
Boats	-	-	5	3	4	4	5	3	4	4	3	5	-	-
SAL	-	-	2	6	4	4	3	5	4	4	5	3	-	-
YEP	-	-	2	6	4	4	4	4	4	4	4	4	-	-
WAE	-	-	4	4	4	4	2	6	4	4	4	4	-	-

Table 6.— Proportional sampling schedule for statistical district MM-4 based on instantaneous boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1 clerk. Sampling schedules are based on 1985-95 data and 1994-96 data.

	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.	
	94	100	94	100	94	100	94	100	94	100	94	100	94	100
Week days														
1985-95														
Boats	4	8	4	8	4	8	4	8	4	8	4	8	4	8
SAL	6	6	4	8	4	8	4	8	5	7	6	6	5	7
YEP	4	8	8	4	6	6	6	6	4	8	6	6	4	8
WAE	6	6	6	6	6	6	6	6	6	6	6	6	4	8
1994-96														
Boats	4	8	4	8	4	8	4	8	4	8	4	8	4	8
SAL	4	8	4	8	4	8	4	8	4	8	4	8	4	8
YEP	6	6	6	6	4	8	6	6	4	8	4	8	4	8
WAE	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Weekend days														
1985-95														
Boats	3	5	3	5	3	5	3	5	3	5	3	5	3	5
SAL	4	4	2	6	2	6	4	4	4	4	3	5	2	6
YEP	2	6	2	6	6	2	4	4	2	6	2	6	6	2
WAE	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1994-96														
Boats	3	5	3	5	3	5	3	5	3	5	3	5	3	5
SAL	4	4	2	6	2	6	4	4	2	6	2	6	2	6
YEP	2	6	4	4	2	6	4	4	2	6	2	6	2	6
WAE	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Table 7.— Proportional sampling schedule for statistical district MM-5 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for ½ time clerk. Site 116 was last sampled in 1988.

	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.	
	116	124	116	124	116	124	116	124	116	124	116	124	116	124
Week days														
1985-88														
Boats	2	4	2	4	2	4	2	4	2	4	2	4	2	4
SAL	2	4	2	4	2	4	3	3	3	3	2	4	2	4
YEP	3	3	3	3	4	2	4	2	3	3	3	3	3	3
WAE	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Weekend days														
1985-88														
Boats	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SAL	2	2	2	2	2	2	2	2	2	2	2	2	2	2
YEP	2	2	2	2	2	2	2	2	2	2	2	2	2	2
WAE	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 8.—Proportional sampling schedule for statistical district MM-6 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1.5 clerks. Site 139 was not sampled in 1989-96. Clerk allocations for site 139 during this time period are minimal (2 days) or equal allocation with adjacent sites.

	Apr.				May				Jun.				Jul.			
	127	128	134	139	127	128	134	139	127	128	134	139	127	128	134	139
Week days																
1985-95																
Boats	2	8	5	3	2	7	6	3	2	6	7	3	2	4	7	5
SAL	4	5	6	3	2	4	4	8	4	4	3	7	5	4	4	5
YEP	2	8	6	2	4	6	6	2	5	2	9	2	2	5	9	2
WAE	4	5	5	4	4	5	5	4	4	5	5	4	4	5	5	4
1994-96																
Boats	2	9	5	2	2	7	7	2	3	7	6	2	2	6	7	3
SAL	5	5	6	2	3	6	6	3	3	6	6	3	5	5	5	3
YEP	2	2	12	2	2	4	10	2	7	2	7	2	6	2	8	2
WAE	4	5	5	4	4	5	5	4	4	5	5	4	4	5	5	4
Weekend days																
1985-95																
Boats	2	4	4	2	2	3	4	3	2	3	3	4	2	3	4	3
SAL	2	3	4	3	2	3	3	4	3	3	3	3	3	3	3	3
YEP	2	4	4	2	2	2	6	2	2	2	6	2	2	2	4	4
WAE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1994-96																
Boats	2	5	3	2	3	4	3	2	2	3	5	2	2	4	4	2
SAL	3	3	4	2	4	3	3	2	4	3	3	2	4	3	3	2
YEP	2	2	6	2	2	2	6	2	2	2	6	2	3	2	5	2
WAE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table 8.— (continued). Proportional sampling schedule for statistical district MM-6 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1.5 clerks. Site 139 was not sampled in 1989-96. Clerk allocations for site 139 during this time period are minimal (2 days) or equal allocation with adjacent sites.

	Aug.				Sep.				Oct.			
	127	128	134	139	127	128	134	139	127	128	134	139
Week days												
1985-95												
Boats	2	6	6	4	2	7	7	2	2	8	6	2
SAL	4	4	4	6	6	4	4	4	7	4	4	3
YEP	2	2	12	2	2	10	4	2	2	3	11	2
WAE	4	5	5	4	4	5	5	4	4	5	5	4
1994-96												
Boats	3	8	6	2	4	5	7	2	3	8	5	2
SAL	6	4	5	3	4	5	6	3	5	5	5	3
YEP	5	2	9	2	12	2	2	2	4	5	5	4
WAE	4	5	5	4	4	5	5	4	4	5	5	4
Weekend days												
1985-95												
Boats	2	3	4	3	2	3	3	4	2	4	4	2
SAL	3	3	3	3	3	2	3	4	4	3	3	2
YEP	3	2	5	2	5	2	3	2	2	6	2	2
WAE	3	3	3	3	3	3	3	3	3	3	3	3
1994-96												
Boats	2	3	5	2	2	5	3	2	2	5	3	2
SAL	4	3	3	2	3	4	3	2	3	3	3	3
YEP	5	2	3	2	6	2	2	2	3	3	3	3
WAE	3	3	3	3	6	2	2	2	3	3	3	3

Table 9.— Proportional sampling schedule for statistical district MM-7 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1 clerk. Site 312 was rarely sampled.

	Apr.			May			Jun.			Jul.		
	312	149	153	312	149	153	312	149	153	312	149	153
Week days												
1985-95												
Boats	2	7	3	2	5	5	4	4	4	2	4	6
SAL	2	3	7	2	4	6	2	4	6	2	4	6
YEP	2	8	2	2	8	2	2	7	3	2	6	4
WAE	4	4	4	4	4	4	4	4	4	2	8	2
1994-96												
Boats	2	7	3	2	6	4	2	5	5	2	6	4
SAL	4	4	4	2	5	5	2	5	5	2	3	7
YEP	2	8	2	2	8	2	2	7	3	2	7	3
WAE	4	4	4	4	4	4	4	4	4	2	8	2
Weekend days												
1985-95												
Boats	2	3	3	2	3	3	2	3	3	2	3	3
SAL	2	2	4	2	3	3	2	3	3	2	3	3
YEP	2	4	2	2	4	2	2	4	2	2	3	3
WAE	2	4	2	2	3	3	2	3	3	2	4	2
1994-96												
Boats	2	3	3	2	3	3	2	3	3	2	3	3
SAL	2	2	4	2	2	4	2	3	3	2	2	4
YEP	2	4	2	2	4	2	2	3	3	2	4	2
WAE	2	4	2	2	3	3	2	3	3	2	4	2

Table 9.—(continued). Proportional sampling schedule for statistical district MM-7 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 1 clerk. Site 312 was rarely sampled.

	Aug.			Sep.			Oct.		
	312	149	153	312	149	153	312	149	153
Week days									
1985-95									
Boats	2	6	4	2	6	4	2	6	4
SAL	2	4	6	2	4	6	2	4	6
YEP	2	7	3	2	3	7	2	7	3
WAE	2	8	2	4	4	4	4	4	4
1994-96									
Boats	2	6	4	2	6	4	2	6	4
SAL	2	5	5	2	6	4	2	5	5
YEP	2	5	5	2	3	7	2	8	2
WAE	2	2	8	4	4	4	4	4	4
Weekend day									
1985-95									
Boats	2	2	4	2	3	3	2	3	3
SAL	2	3	3	2	3	3	2	2	4
YEP	2	4	2	2	4	2	2	2	4
WAE	2	4	2	2	3	3	2	3	3
1994-96									
Boats	2	3	3	2	3	3	2	3	3
SAL	2	2	4	2	3	3	2	3	3
YEP	2	4	2	2	4	2	2	3	3
WAE	2	4	2	2	3	3	2	3	3

Table 10.—Proportional sampling schedule for statistical district MM-8 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 2 clerks. Site 160 was not sampled 1989-96. Clerk allocations for site 160 during this time period are minimal (2 days) or equal allocation with adjacent sites.

	Apr.					May					Jun.					Jul.				
	156	160	162	164	166	156	160	162	164	166	156	160	162	164	166	156	160	162	164	166
Week days																				
1985-95																				
Boats	2	3	10	5	4	5	3	8	5	3	4	7	5	5	3	4	10	4	3	3
SAL	3	2	3	7	9	6	5	2	5	6	6	2	3	6	7	9	3	3	3	6
YEP	2	2	16	2	2	2	2	16	2	2	3	3	8	6	4	2	3	8	7	4
WAE	2	2	2	2	16	2	9	2	9	2	2	9	2	9	2	2	12	2	6	2
1994-96																				
Boats	2	2	14	4	2	4	2	11	4	3	5	2	9	5	3	6	2	7	6	3
SAL	4	2	3	5	10	8	2	2	5	7	7	2	3	6	6	8	2	4	5	5
YEP	2	2	16	2	2	2	2	16	2	2	2	2	12	3	5	3	2	8	5	6
WAE	5	4	5	5	5	5	4	5	5	5	5	4	5	5	5	5	4	5	5	5
Weekend days																				
1985-95																				
Boats	2	4	4	4	4	2	6	2	3	3	3	4	3	3	3	2	4	4	3	3
SAL	3	2	2	4	5	4	3	2	3	4	6	2	2	2	4	6	2	2	3	3
YEP	2	2	8	2	2	2	2	8	2	2	2	3	5	4	2	3	2	4	4	3
WAE	2	8	2	2	2	2	7	3	2	2	2	4	4	4	2	2	2	4	6	2
1994-96																				
Boats	2	2	7	3	2	3	2	5	4	2	5	2	4	3	2	3	2	6	3	2
SAL	2	2	2	4	6	5	2	2	3	4	4	2	2	4	4	7	2	2	3	2
YEP	2	2	8	2	2	2	2	8	2	2	2	2	8	2	2	3	2	5	2	4
WAE	3	3	4	3	3	3	3	4	3	3	2	2	8	2	2	2	2	8	2	2

Table 10.—(continued). Proportional sampling schedule for statistical district MM-8 based on interval boat counts; and catch rates of salmon (SAL), yellow perch (YEP), and walleye (WAE). Monthly sample sizes (clerk days) are for 2 clerks. Site 160 was not sampled 1989-96. Clerk allocations for site 160 during this time period are minimal (2 days) or equal allocation with adjacent sites.

	Aug.					Sep.					Oct.				
	156	160	162	164	166	156	160	162	164	166	156	160	162	164	166
Week days															
1985-95															
Boats	5	8	5	4	2	8	3	6	5	2	7	4	6	2	5
SAL	6	5	4	5	4	10	4	4	3	3	6	4	4	4	6
YEP	5	2	6	5	6	4	2	6	6	6	2	2	10	7	3
WAE	5	4	5	5	5	4	8	4	4	4	5	4	5	5	5
1994-96															
Boats	6	2	8	6	2	6	2	9	4	3	4	2	9	4	5
SAL	11	2	4	3	4	10	2	4	4	4	8	2	2	7	5
YEP	4	2	6	6	6	5	2	13	2	2	2	2	8	9	3
WAE	5	4	5	5	5	5	4	5	5	5	5	4	5	5	5
Weekend days															
1985-95															
Boats	2	6	2	3	3	3	4	3	3	3	3	2	4	3	4
SAL	4	3	4	2	3	4	5	3	2	2	4	2	2	2	6
YEP	2	2	4	3	5	3	2	5	3	3	2	2	4	6	2
WAE	2	6	3	3	2	2	5	2	5	2	3	3	3	3	4
1994-96															
Boats	3	2	5	4	2	4	2	3	5	2	3	2	5	3	3
SAL	5	2	4	3	2	6	2	2	4	2	4	3	3	3	3
YEP	3	2	5	2	4	2	2	7	2	3	4	2	6	2	2
WAE	3	3	4	3	3	4	3	3	3	3	3	3	4	3	3

Table 11.—Results of proportional sampling by statistical district in Michigan waters of Lake Michigan. Proportional sampling allocation of effort was done by angling effort (counts), and catch rate of salmon, walleye and yellow perch.

Statistical district	Works	Does not work
1		X
2	X	
3*	X	
4	X	
5*	X	
6		X
7	X	
8		X

* Sampling was 1:1, so either proportional or equal sampling was appropriate.

Table 12.—Travel times and distances between Lake Michigan survey sites 1 - 48 in statistical districts MM-1 and MM-2. When one clerk samples from site 1 to site 18 and returns to site 1, wait time per site is 1.81 h with 102.8 miles driven. When second clerk samples from site 20 to site 48 and returns to site 20, wait time per site is 1.35 h with 92.4 miles driven.

Sites	Time between sites (min)	Miles between sites
1,7		
	50	29.4
15		
	27	22.0
18		
	25	8.7
20		
	33	12.2
25		
	37	28.4
46		
	8	5.6
48		

Table 13.—Travel times and distances between Lake Michigan survey sites 80 - 100 in statistical districts MM-3 and MM-4. When one clerk samples from site 80 to site 85 and returns to site 85, wait time is 2.9 h per site with 102.0 miles driven. When second clerk samples from site 90 to site 100 and returns to site 100, wait time per site is 1.70 h with 90.0 miles driven.

Sites	Time between sites (min)	Miles between sites
80,84		
	65	12.0
85		
	88	39.0
90		
	34	10.8
94		
	53	34.2
100		

Table 14.—Travel times and distances between Lake Michigan survey sites 116 - 166 in statistical districts MM-5 through MM-8. When one clerk samples from site 116 to site 127 and returns to site 116, wait time is 1.27 h per site with 161.6 miles driven. When second clerk samples from site 128 to site 312 and returns to site 128, wait time per site is 1.16 h with 160.6 miles driven. When third clerk samples from site 149 to site 160 and returns to site 149, wait time per site is 1.22 h with 96.0 miles driven. When fourth clerk samples from site 162 to site 166 and returns to site 162, wait time per site is 1.71 h with 114.2 miles driven.

Sites	Time between sites (min)	Miles between sites
116		
	81	51.3
124		
	45	29.5
127		
	24	15.0
128		
	41	30.0
134		
	22	15.5
139		
	38	34.8
312		
	44	19.0
149		
	17	10.0
153		
	30	17.0
156		
	47	21.0
160		
	28	19.0
162		
	41	26.1
164		
	45	31.0
166		

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