STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-2

Study No.: 673 **Title:** Evaluation of on-site angler survey methods

Period Covered: October 1, 2000 to September 30, 2001

Study Objective: Determine if mean-of-ratios estimator provides an unbiased estimate of angler catch rate for Michigan angler surveys utilizing roving interviews and determine if angling effort may be accurately estimated from access interview distribution of angler activity.

Summary: Access surveys use angler interviews from completed-angler trips while roving surveys use interviews from incompleted-angler trips. Catch rates are calculated using a ratio-of-means estimator for access interviews and a mean-of-ratios estimator for roving interviews (Lockwood 1997; Jones et al. 1995). Access interviews may be recorded by angling party or by individual angler while catch information from roving interviews are recorded by individual angler to avoid angler party size bias (Lockwood 1997). When roving interviews are collected, anglers are interviewed prior to completion of their angling trip. Recommended minimum fishing time for each roving interview is 0.5 h (Pollock et al. 1997). Pollock et al. (1997) shows that accuracy of roving interview catch rates may be affected by bag limits.

To test the assumptions that roving-interview catch rates are not different from access-interview catch rates and 0.5-h minimum fishing time for roving interviews is appropriate, both interview types were collected from anglers fishing at two sites during 1999. The Au Sable River (Oscoda, Alcona, and Iosco counties) was surveyed during the summer months of 1999. Here nine different river sections were sampled. The second site, Lake Gogebic (Ontonagon and Gogebic counties), was sampled during the winter months of 1999. Lake Gogebic was stratified into three sampling sections.

Job 2. Title: Compare catch rates.

Findings: *Au Sable River, summer 1999.*–Using methods for a multiple-day period (Lockwood et al. 1999), angler creel surveys were conducted at nine sections (34 river miles) of the Au Sable River and on three Au Sable River impoundments (Table 1). Survey data were collected during spring to fall months in 1999 (Table 2). Both harvested and caught-and-released fish were recorded by species. Two modes of angling were sampled (boat and shore/wading) over a 5-month period. Anglers were either interviewed as they fished (roving interview) or at the completion of their trip (access interview). All interviews, regardless of type, were by individual angler. Additional survey descriptions may be found in Lockwood (2000a) and Lockwood (in press).

Lake Gogebic, winter 1999.–An angler creel survey was conducted on Lake Gogebic during winter months, 1999. Similar to Au Sable River survey, multiple-day period methods were used (Lockwood et al. 1999). Lake was stratified into three grids (Figure 1). Survey data were collected between January 4 and April 10, 1999. Both harvested and caught-and-released fish were recorded by species. Two modes of angling were sampled (open ice and shanty) during the survey period. Anglers were either interviewed as they fished (roving interview) or at the

completion of their trip (access interview). All interviews, regardless of type, were by individual angler. Additional survey descriptions may be found in Lockwood (2000b).

Methods.–Comparisons of access and roving catch rate estimates were made within individual site-time period-mode-species data sets, and across site-time period-species data sets for each of the two surveys. All catch rates are in fish per hour. Bootstrapping techniques with 10,000 replications were used to calculate within-data-set differences in catch rates. The percentile method for detecting differences in catch rates was used and differences were considered statistically significant when 0.0000 was not included in the central 95% bootstrap differences (Efron and Tibshirani 1993). Ten thousand replications have been shown adequate to overcome severe deviations from normality in data sets and correctly represent confidence limits (Buckland 1984).

Across-data-set differences were evaluated using Wilcoxon signed ranks test for paired data. Ratio-of-means catch per hour for access interviews and mean-of-ratios catch per hour for roving interviews were calculated, appropriately, for each data set. The two surveys (Au Sable River and Lake Gogebic) were considered and evaluated separately.

Au Sable River, results.–Catch rate comparisons were made for 362 paired data sets. Number of access interviews per data set varied from 3 to 79 records. Mean number of access interview records was 21.3 (SD = 17.6). Length of completed fishing trip varied from 0.5 h to 13.5 h (Figure 2) with mean 3.2 h (SD = 2.4 h). Number of roving interviews per data set varied from 3 to 98 records. Mean number of roving interview records was 26.7 (SD = 22.2). Length of incompleted fishing trip varied from 0.5 h to 16.5 h (Figure 3) with mean 2.5 h (SD = 2.3 h).

For the 362 within-data-set catch-rate comparisons, 34 (9.4%) catch rates were significantly different ($P \leq 0.05$). Mean-of-ratios estimate from roving interviews was significantly greater than ratio-of-means estimate from access interviews 22 times (Table 3). Ratio-of-means estimate from access interviews was significantly greater than mean-of-ratios estimate from roving interviews 12 times.

Across data sets, mean catch rate of roving-interview data sets was significantly different from mean catch rate of access-interview data sets (Wilcoxon Signed Ranks Test, $N = 362$, $P < 0.001$). Mean catch rate of roving-interview data sets was 0.1483 and mean catch rate of access-interview data sets was 0.1083.

Roving interview records with trip lengths less than 1.0 h were removed from the data set. Previously, 0.5-h minimum trip length was considered adequate for roving interviews (Pollock et al. 1997). Resulting data set now contained 351 paired data sets. While no access-interview records were removed due to trip length, paired data sets with catch rates of 0.0000 for both access and roving interviews were not included. Number of roving interviews per data set varied from 3 to 72 records. Mean number of roving-interview records was 21.4 (SD = 18.0). Length of incompleted fishing trip varied from 1.0 h to 16.5 h with mean 3.1 h (SD = 2.3 h).

For the 351 within-data-set catch-rate comparisons, 24 (6.8%) catch rates were significantly different ($P \leq 0.05$). Mean-of-ratios estimate from roving interviews was significantly greater than ratio-of-means estimate from access interviews 14 times (Table 3). Ratio-of-means estimate from access interviews was significantly greater than mean-of-ratios estimate from roving interviews 10 times.

Across data sets, mean catch rate of roving-interview data sets was significantly different from mean catch rate of access-interview data sets (Wilcoxon Signed Ranks Test, $N = 351$, $P = 0.010$).

Mean catch rate of roving-interview data sets was 0.1265 and mean catch rate of access-interview data sets was 0.1105.

Additional removal of roving interviews based on trip length was done. Now minimum roving interview fishing time was 1.5 h. This further reduced paired comparisons to 335 paired data sets. As with previous roving-trip-length reduction, no access-interview records were removed due to trip length, paired data sets with catch rates of 0.0000 for both access and roving interviews were not included. Number of roving interviews per data set varied from 3 to 60 records. Mean number of roving-interview records was 15.8 (SD = 13.3). Length of incompleted fishing trip varied from 1.5 h to 16.5 h with mean 3.7 h (SD = 2.4 h).

Within-data-set differences were not measured.

Across data sets, mean catch rate of roving-interview data sets was significantly different from mean catch rate of access-interview data sets (Wilcoxon Signed Ranks Test, $N = 336$, $P = 0.017$). Mean catch rate of roving-interview data sets was 0.1429 and mean catch rate of access-interview data sets was 0.1000.

Lake Gogebic, results.–Catch-rate comparisons were made for 99 paired data sets. Number of access interviews per data set varied from 5 to 185 records. Mean number of access-interview records was 44.1 (SD = 50.8). Length of completed fishing trip varied from 0.5 h to 11.5 h (Figure 4) with mean 5.4 h (SD = 2.0 h). Number of roving interviews per data set varied from 3 to 55 records. Mean number of roving-interview records was 26.2 (SD = 15.1). Length of incompleted fishing trip varied from 1.0 h to 14.5 h (Figure 5) with mean 3.4 h (SD = 2.2 h).

No roving interviews with fishing time less than 1.0 h were collected. Thus, comparisons began for roving-interview fishing time $\geq$ 1.0 h. For the 99 within-data-set catch-rate comparisons, 11 (11.1%) catch rates were significantly different ($P \leq 0.05$). Mean-of-ratios estimate from roving interviews was significantly greater than ratio-of-means estimate from access interviews 4 times (Table 4). Ratio-of-means estimate from access interviews was significantly greater than mean-of-ratios estimate from roving interviews 7 times.

Across data sets, mean catch rate of roving-interview data sets were not significantly different from mean catch rate of access-interview data sets (Wilcoxon Signed Ranks Test, $N = 99$, $P = 0.942$). Mean catch rate of roving-interview data sets was 0.0699 and mean catch rate of access-interview data sets was 0.0675.

Additional removal of roving interviews based on trip length was done. Now minimum roving-interview fishing time was 1.5 h. This further reduced paired comparisons to 95 paired data sets. As with previous roving-trip-length reduction, no access-interview records were removed due to trip length, paired data sets with catch rates of 0.0000 for both access and roving interviews were not included. Number of roving interviews per data set varied from 4 to 47 records. Mean number of roving-interview records was 24.2 (SD = 13.3). Length of incompleted fishing trip varied from 1.5 h to 14.5 h with mean 3.8 h (SD = 2.1 h).

Within-data-set differences were not measured.

Across data sets, mean catch rate of roving-interview data sets was not significantly different from mean catch rate of access-interview data sets (Wilcoxon Signed Ranks Test, $N = 95$, $P = 0.928$). Mean catch rate of roving-interview data sets was 0.0720 and mean catch rate of access-interview data sets was 0.0675.

Based on these results, MDNR Fisheries Division should continue use of roving data, but increase minimum roving trip length to 1.0 h.

Job 4. Title: Evaluate counting methods.

Findings: Results of Job 4 are given in the following report:

Lockwood, R. N., J. Peck, and J. Oelfke. 2001. Survey of angling in Lake Superior waters at Isle Royale National Park, 1998. North American Journal of Fisheries Management 21:471-481.

Literature Cited:

Buckland, S. T. 1984. Monte Carlo confidence intervals. Biometrics 40:811-817.

Efron, B., and R. J. Tibshirani. 1993. An introduction to the bootstrap. Chapman & Hall, New York, New York, USA.

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.

Lockwood, R. N. In press. Inland creel surveys, progress report, study 646. Michigan Department of Natural Resources, Federal Aid in Sport Fish Restoration, Annual Reports for Projects F-81-R-2 and F-80-R-2.

Lockwood, R.N. 2000b. Inland creel surveys, progress report, study 646. Michigan Department of Natural Resources, Federal Aid in Sport Fish Restoration, Annual Reports for Projects F-81-R-1 and F-80-R-1. http://www.dnr.state.mi.us/www/ifr/ifrhome/FederalAid/FRI_F81R1/Study%20646.pdf (25 Sept. 2001).

Lockwood, R. N. 2000b. Sportfishing angler surveys on Michigan Inland waters, 1993-99. Michigan Department of Natural Resources, Fisheries Technical Report 2000-3, Ann Arbor.

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

Lockwood, R. N., D. M. Benjamin, and J. R. Bence. 1999. 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.

Pollock, K. H., J. M. Hoenig, C. M. Jones, D. S. Robson, and C. J. Greene. 1997. Catch rate estimation for roving and access point surveys. North American Journal of Fisheries Management 17:11-19.

Prepared by: Roger N. Lockwood
Date: September 30, 2001

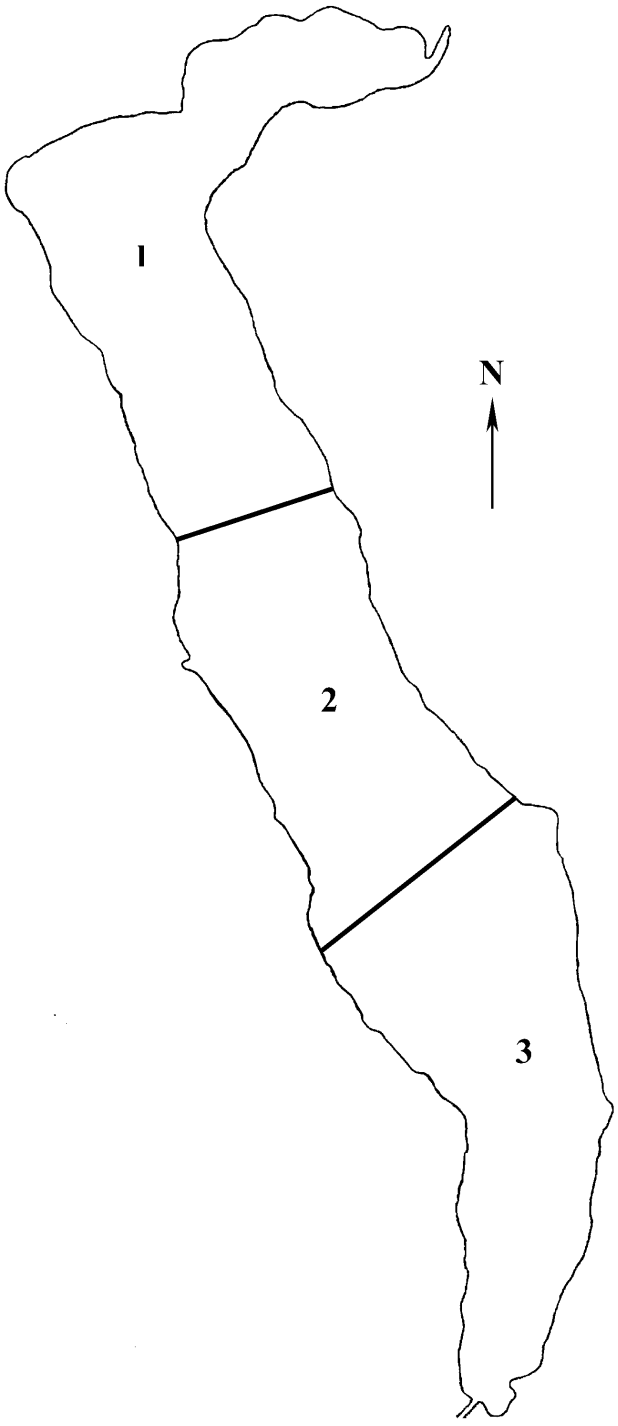

Figure 1.–Lake Gogebic sample grids, winter angler creel survey 1999.

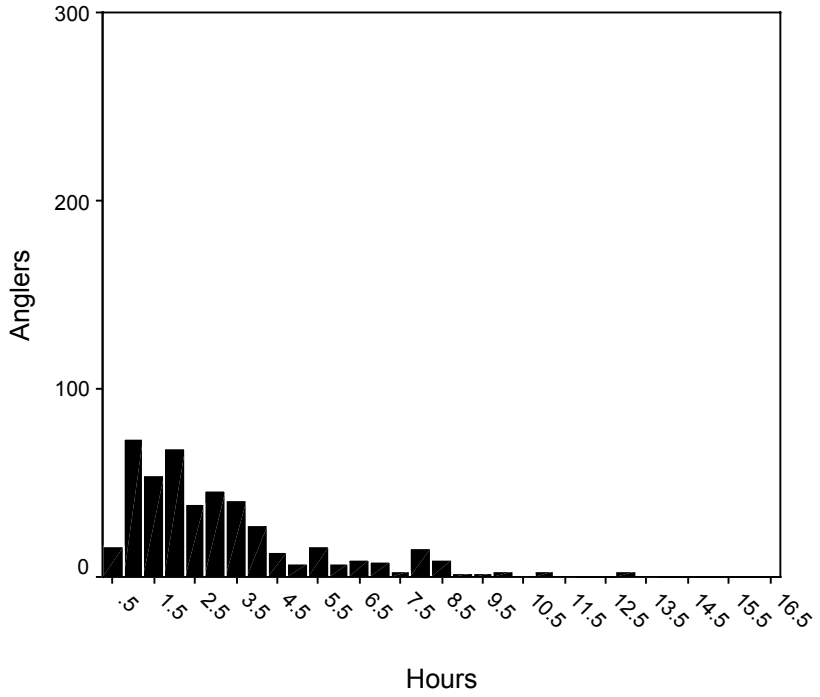

Figure 2.–Distribution of access-interview trip length (completed trip) for anglers fishing in nine sections of the Au Sable River, summer 1999.

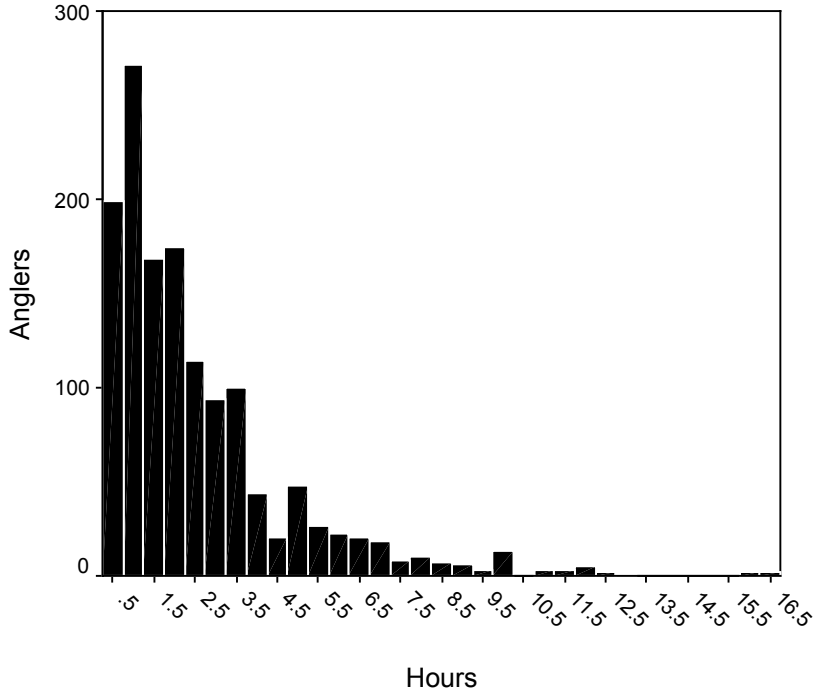

Figure 3.–Distribution of roving-interview trip length (incomplete trip) for anglers fishing in nine sections of the Au Sable River, summer 1999.

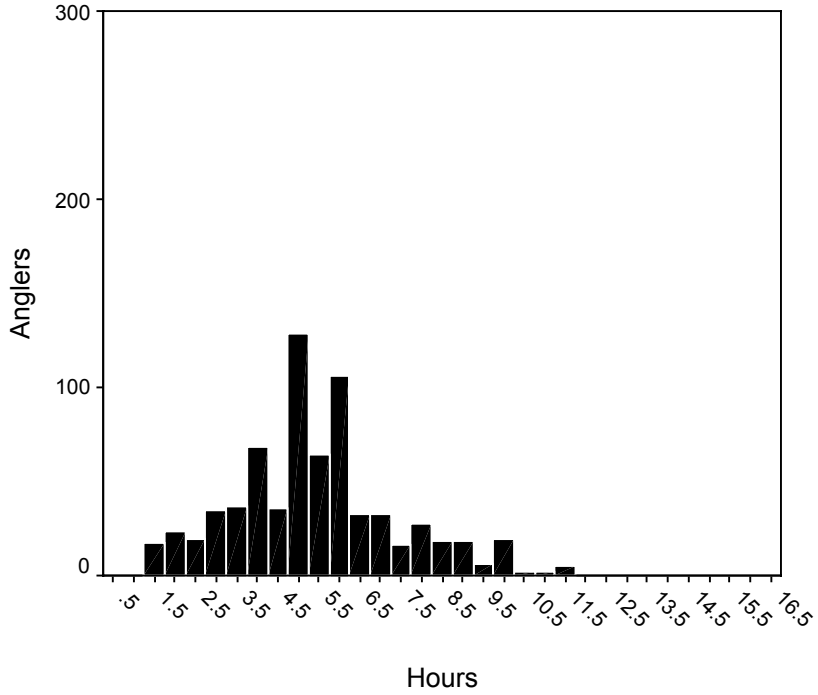

Figure 4.–Distribution of access-interview trip length (completed trip) for anglers fishing in three sections of Lake Gogebic, winter 1999.

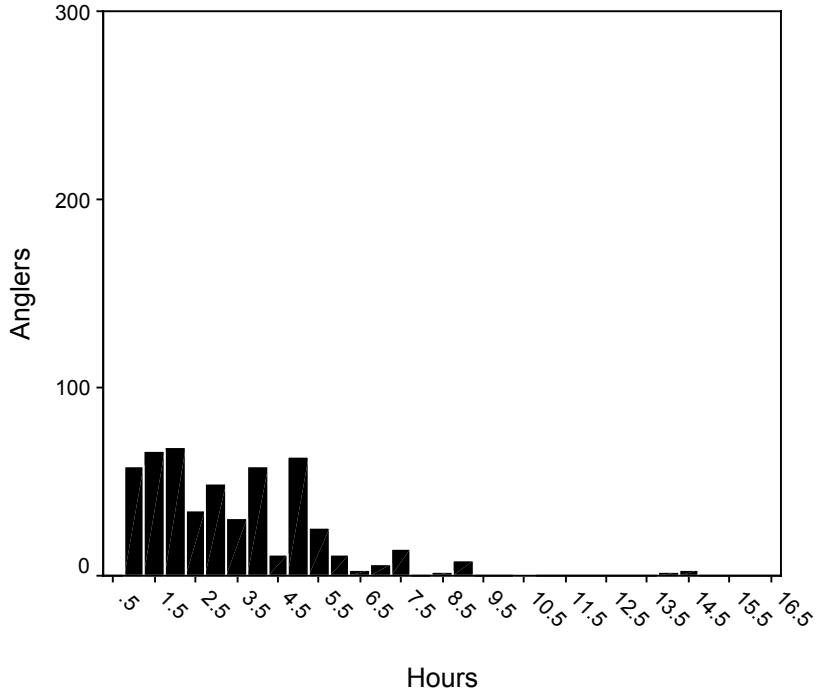

Figure 5.–Distribution of roving-interview trip length (incomplete trip) for anglers fishing in three sections of Lake Gogebic, winter 1999.

Table 1.–Au Sable River angler-survey sections, 1999. Lengths were measured using ArcView 3.1 (Environmental Systems Research Institute, Inc.).

Section code	Boundaries	Name	Length (miles)
240	End of riverine stretch to Mio Dam	Mio Pond	-
250A	M-33 to Power Line	-	0.46
250B	Power Line to Comins Flats	-	6.96
251	Comins Flats to McKinley Bridge	-	7.58
252	McKinley Bridge to 4001 Bridge	-	7.09
254	1.65 miles below 4001 Bridge to Alcona Dam	Alcona Impoundment	-
255	Alcona Dam to Hoppy Creek	-	6.57
256	Hoppy Creek to end of riverine stretch above Loud Impoundment		5.50
257	End of Riverine stretch to Loud Dam	Loud Impoundment	-

Table 2.–Beginning and ending period dates of Au Sable River angler-surveys, 1999, by survey section. See Table 1 for description of survey sections.

240, 250	250A, 250B, 251, 252	255, 256, 257
April 24 – May 31	April 24 – June 7	May 20-31
June 1-30	June 8 – July 15	June 1-30
July 1-31	July 16 – August 24	July 1-31
August 1-31	August 25 – September 7	August 1-31
September 1-30	September 8-30	September 1-30

Table 3.–Comparisons of Au Sable River access-interview and roving-interview catch-rates. Data are from nine river sections and were collected during summer 1999. Number of paired data sets (N) included in the calculations varies with the criterion for minimum roving trip length. Catch rates were calculated using a ratio-of-means estimator ($\hat{R}$) for access interviews and a mean-of-ratios estimator ($\overline{R}$) for roving interviews. Comparisons were made across site-time period-species data sets, and within individual site-time period-mode-species data sets. For within data sets analysis, the numbers of significant differences are indicated and the percent of significant differences detected from those data set comparisons. Based on these results, MDNR Fisheries Division should continue use of roving data, but increase minimum roving trip length to 1.0 h.

	Across data sets				Within data sets		
		Access	Roving		Bootstrap differences ($P \leq 0.05$)[b]		
Minimum trip length (h)	N	$\hat{R}$	$\overline{R}$	Significance[a]	$\hat{R} > \overline{R}$	$\hat{R} < \overline{R}$	Percent
0.5	362	0.1083	0.1483	<0.001	12	22	9.4
1.0	351	0.1105	0.1265	0.010	10	14	6.8
1.5	336	0.1000	0.1429	0.017	-	-	-

[a] Wilcoxon signed ranks test for paired data.
[b] Central 95% bootstrap differences for 10,000 replicates do not include 0.0000.

Table 4.–Comparisons of Lake Gogebic access-interview and roving-interview catch-rates. Data are from three lake sections and were collected during winter 1999. Number of paired data sets (N) included in the calculations varies with the criterion for minimum roving trip length. Catch rates were calculated using a ratio-of-means estimator ($\hat{R}$) for access interviews and a mean-of-ratios estimator ($\overline{R}$) for roving interviews. Comparisons were made across site-time period-species data sets, and within individual site-time period-mode-species data sets. For within data sets analysis, the numbers of significant differences are indicated and the percent of significant differences detected from those data set comparisons. Based on these results, MDNR Fisheries Division should continue use of roving data, but increase minimum roving trip length to 1.0 h.

	Across data sets				Within data sets		
		Access	Roving		Bootstrap differences ($P \leq 0.05$)[b]		
Minimum trip length (h)	N	$\hat{R}$	$\overline{R}$	Significance[a]	$\hat{R} > \overline{R}$	$\hat{R} < \overline{R}$	Percent
0.5	-	-	-	-	-	-	-
1.0	99	0.0675	0.0699	0.9420	7	4	11.1
1.5	95	0.0675	0.0720	0.9280	-	-	-

[a] Wilcoxon signed ranks test for paired data.
[b] Central 95% bootstrap differences for 10,000 replicates do not include 0.0000.