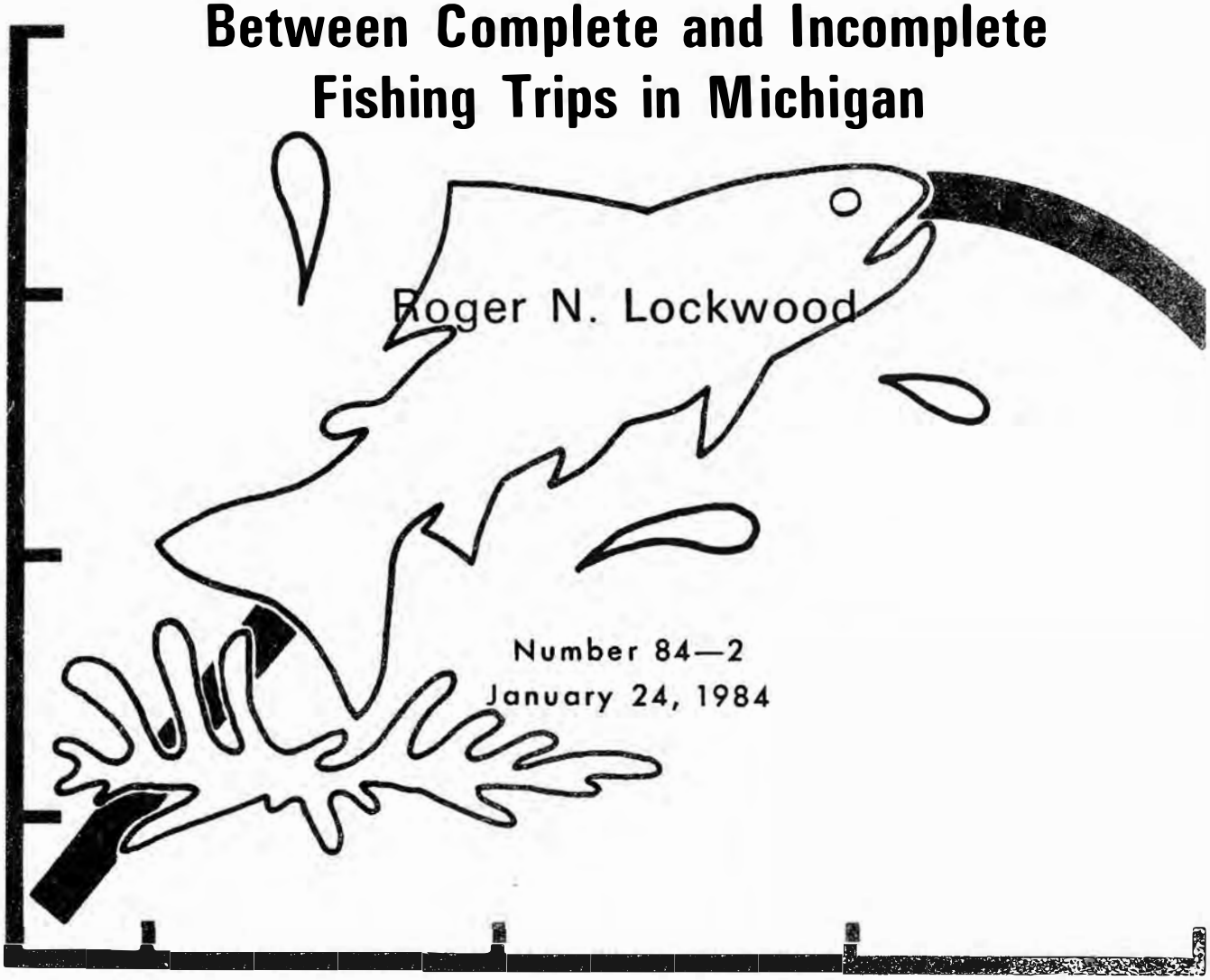
FISHERIES DIVISION

TECHNICAL REPORT

A Statistical Comparison of Catch Per Hour Rates Between Complete and Incomplete Fishing Trips in Michigan



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Roger N. Lockwood

Abstract

Creel census data collected from Michigan anglers are frequently composed of complete and incomplete fishing trip interviews. The purpose of this study was to compare catch rates, by species, of complete and incomplete fishing trips. In each comparison, variances of catch rates were first tested to determine equivalency. The appropriate t test was then applied and statistical differences were determined, at the 5% level of significance. Data collected indicated that the catch per hour rates of incomplete trips were different from complete fishing trips more than 20% of the time.

Introduction

The creel census is an important tool for monitoring fisheries. Managers can use a census to estimate the amount of fishing effort occurring and to help determine the effects of fishing on the fish stocks. Both biological and sociological information can be obtained from census and these data are vital for making management decisions such as evaluating the need for regulations or stocking. In most censuses, anglers are either interviewed while they are fishing (incomplete interview) or after they complete their fishing trip (complete interview). Basic information recorded during an interview includes: fishing location, date, type of fishing (boat, shore, or pier), whether the trip is complete or incomplete, number of anglers in the party, length of the fishing trip, and the number of fish (by species) caught and kept by the fishing party. Surveys being run over large bodies of water, or on areas having many access points, frequently include large numbers of incomplete interviews (Geis and Gustafson 1977). Thus, catch estimates may be based almost entirely on incomplete interviews.

Few studies have been conducted to compare catch rates of complete versus incomplete fishing trips, but I did find two studies (Malvestuto, Davies, and Shelton 1978; and Fierstine, Geis, and Gustafson 1978) and they both concluded that no

significant differences existed between these catch rates. However, I made the same comparison, using data from four Michigan censuses, and found that significant differences did exist.

Study Areas and Methods

The original purposes of the four surveys used to compare complete and incomplete catch rates were to estimate the number of angler fishing trips, hours fished, and the numbers of fish caught (by species). The species of fish available at each site varied, and only those species which were most abundant in the anglers' creels were used for this analysis. Also, only interviews from shore anglers were examined.

In the spring, 1980, a creel census was conducted on the Grand River, which flows 478 miles through southwestern Michigan before emptying into Lake Michigan at Grand Haven. Anglers were counted and interviewed at the 6th Street Dam in Grand Rapids during March and April. The species of fish of major concern during this census was the rainbow trout (Salmo gairdneri).

From May through October, in 1978, anglers fishing from Chesterfield Pier, located on Lake St. Clair (Wayne County, Chesterfield Township) were interviewed. The main species of fish taken by these anglers were rock bass (Ambloplites rupestris), yellow perch (Perca flavescens), and freshwater drum (Aplodinotus grunniens).

From June to August in 1976 and from April to October in 1977, Belleville Lake, a 1,270-acre impoundment on the Huron River, was censused. Anglers were interviewed at various points along the shore line. Here the fish examined were bluegill (Lepomis macrochirus), sunfish sp. (Lepomis sp.), and black crappie (Pomoxis nigromaculatus).

Angling parties interviewed at each location fished a minimum of 0.5 hour and each fishing trip was recorded to the nearest 0.5 hour. Catch per hour (C/H) rates were calculated by party, thus, if two anglers fished 5 hours and caught one rainbow trout, the C/H would be 0.1. Since catch rates are

typically calculated by species and time period (i.e., month), no catch rates by season or with species combined were determined (Tait 1953). Data were not used for months in which one interview type (complete or incomplete) represented less than 10% of the opposing interview type in sample size.

For each month variances of mean catch rates for complete (S_C^2) and incomplete (S_I^2) interviews were tested to determine equivalence. Equivalence of variances were tested first to determine the correct test to compare means. The method used for this test (Dixon and Massey 1951) is as follows:

a. $H: \alpha_1^2 = \alpha_2^2$,

b. Choose significance level of test (α),

c. Use the statistics $F = (S_1^2/S_2^2)$ to test the hypothesis,

d. If the observations are random samples from normal populations, and if the hypothesis is true, then the sampling distribution of this statistic is $F\ (N_1\text{-}1,\ N_2\text{-}1)$,

e. Reject if $F > F_{1-\frac{1}{2}\alpha}(N_1\text{-}1,\ N_2\text{-}1)$ or,

   if $F < F_{\frac{1}{2}\alpha}(N_1\text{-}1,\ N_2\text{-}1)$,

f. Compute the F from sample, and reject or accept the hypothesis.

When differences between S_I^2 and S_C^2 were noted, the mean catch rates were compared using the $\underline{t}'$ test found in Snedecor and Cochran (1971),

where,

$$\underline{t}' = (\bar{X}_1 - \bar{X}_2) \,/\, \sqrt{S_1^2/N_1 + S_2^2/N_2}$$

the significance level of $\underline{t}'$ (df) is,

$$(W_1\, \underline{t}_1 + W_2\, \underline{t}_2) \,/\, (W_1 + W_2)$$

when,

$W_1 = S_1^2 / N_1$, and

$W_2 = S_2^2 / N_2$.

If $\underline{t}' > t'_{(df)}$, the difference is significant at that given level. The standard $\underline{t}$ test, using a pooled $S_{\bar{X}}^2$, was used when $S_I^2 = S_C^2$ and is also found in Snedecor and Cochran (1971),

where,

$$\underline{t} = (\bar{X}_1 - \bar{X}_2) \Big/ \sqrt{\frac{S^2 (N_1 + N_2)}{N_1 N_2}}$$

and,

$$S^2 = \frac{\{X_1^2 - (X_1)^2/N_1\} + \{X_2^2 - (X_2)^2/N_2\}}{N_1 + N_2 - 2}$$

if,

$$\underline{t}_{(df_{N-1})} > \underline{t}, \quad \text{then, } \bar{X}_1 = \bar{X}_2.$$

The $\underline{t}$ test with a pooled $S_{\bar{X}}^2$ should not be used when $S_I^2 \neq S_C^2$ because, when the larger sample has the smaller $S_{\bar{X}}^2$, it results in a significant difference being found too often. Conversely, when the larger sample has the larger $S_{\bar{X}}^2$, significant differences may go undetected (Snedecor and Cochran 1971). This same problem would also result if an analysis of variance were used to test means.

Tests using confidence limits about the means also proved unreliable. A significant difference was noted in only 1 case out of 44 when confidence limits were used, while the $\underline{t}'$ test indicated a difference in 9 additional cases. Since the confidence limits do not extract between sample variation, significant differences appear to go undetected.

Statistical differences were tested at the 5% level of significance.

Results

There was a significant difference between catch rates of rainbow trout for complete versus incomplete interviews for March and April of 1980, on the Grand River. In both instances

mean catch rates were greater for incomplete than for complete fishing trips (Table 1).

The 1973 data from Lake St. Clair, Chesterfield Pier, showed significant differences between catch rates for complete versus incomplete interviews for yellow perch and drum in June, drum in July, and yellow perch in August. Here mean catch rates were greater for complete fishing trips than for incomplete fishing trips (Table 2).

On Belleville Lake in 1977, significant differences occurred for bluegill in May, for sunfish sp. in June, for black crappie in July, and for bluegill in October. The catch rates for incomplete angler trips were greater than those for complete angler trips (Table 3).

No significant differences were detected for catch rates on Belleville Lake in 1976 (Table 4).

The $\underline{t}$ test, using a pooled variance was used on Lake St. Clair for 1978 during May for yellow perch and June for rock bass (Table 2), and on Belleville Lake for 1977 during September for bluegill and black crappie and October for sunfish sp. and black crappie (Table 3). In each of these instances, no significant differences were found. All of the remaining comparisons were made utilizing the $\underline{t}'$ test where $S_I^2 \neq S_C^2$.

Of the total 44 comparisons made, statistical differences, at the 5% level, were detected in 10 instances. This is equivalent to a 23% difference rate for the data tested.

Discussion

Differences in catch rates between complete and incomplete interviews were detected more than 20% of the time in the data I used. This suggests that future data collected should be tested prior to having complete and incomplete interviews combined.

Incomplete interviews had significantly higher catch rates than complete interviews from Belleville Lake (1977) and on the Grand River. This seemed to indicate that anglers continued to fish until their success rates remained low for a given period of time. Anglers on Chesterfield Pier, however,

appeared to continue fishing until their trip was successful. In each of these cases, the relationship between significantly different catch rates remained constant for that particular survey. This would seem to indicate the presence of factors which may enable a fisheries manager to predict the type of interviews necessary for an accurate survey. These factors may include such things as, the group of key species of fish being sampled, type of water, and time of year.

The major drawback in predicting the necessity for a high percentage of complete interviews is the manpower requirement for a survey of this type. One alternative to increasing manpower would be to extend the length of the census clerk's day. For example, if most anglers fish until 9 pm and the census clerk quits at 8 pm, many complete interviews would be missed. By moving the clerk's work day from 11 am - 8 pm to 1 pm - 10 pm, this problem would be solved. A second solution would be to adjust incomplete catch rates on data which have already been collected. Since the data tested seem to indicate that this bias is consistant for a particular survey, an adjustment factor should be relatively easy to calculate.

Increasing the minimum time limit on incomplete interviews from 0.5 hour may also improve the accuracy of their catch rates. Data previously collected may be analyzed to determine the minimum acceptable trip length. Interviews containing trips less than this minimum may be discarded and the remaining data processed with the complete interviews. While the sample size, and therefore precision, is decreased, the improved accuracy of the estimates may be improved. Realizing the minimum trip length requirement, fisheries managers would thus be able to caution creel census clerks against collecting incomplete interviews, in the future, from anglers fishing less than the alloted time. Additional analysis will be necessary to determine if appropriate minimum trip lengths vary between surveys.

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Table 1.: Catch rates of rainbow trout for complete and incomplete angler trips with t and F statistics for the Grand River in 1980.

Month	Complete		Incomplete		F	Lower limit	Upper limit	Student t	$t_{0.05}$
	No.	C/H	No.	C/H					
March	54	0.0682	52	0.1726	0.4180	0.5650	1.77	2.7641	2.0086*
April	79	0.1579	84	0.2648	0.3333	0.6452	1.55	2.1611	1.9901*

* Significant at $\alpha = 0.05$.

Table 2. Catch rates for complete and incomplete angler trips with t and F statistics on Lake St. Clair, Chesterfield Pier, in 1978.

Month and species	Complete No.	Complete C/H	Incomplete No.	Incomplete C/H	F	Lower limit	Upper limit	Student t	$t_{0.05}$
May									
Rock bass	107	0.0752	65	0.1540	0.3004	0.6426	1.7390	1.1337	1.9978
Yellow perch	107	0.0081	65	0.0069	1.0707	0.6426	1.7390	0.1638	1.9749
Drum	107	0.0169	65	0.0	0.0	0.6426	1.7390	1.5374	1.9840
June									
Rock bass	151	0.0286	26	0.0251	0.8783	0.6141	1.9100	0.1608	2.0485
Yellow perch	151	0.0064	26	0.0	0.0	0.6141	1.9100	2.6469	1.9749*
Drum	151	0.1694	26	0.0	0.0	0.6141	1.9100	4.3099	1.9749*
July									
Rock bass	128	0.0031	59	0.0	0.0	0.6623	1.5600	1.7051	1.9799
Yellow perch	128	0.0226	59	0.0040	103.1235	0.6623	1.5600	0.8854	1.9803
Drum	128	0.0253	59	0.0025	61.8099	0.6623	1.5600	2.4152	1.9806*
August									
Rock bass	93	0.0008	42	0.0	0.0	0.5952	1.7600	0.9956	1.9867
Yellow perch	93	0.0111	42	0.0019	9.1229	0.5952	1.7600	2.1164	1.9933*
Drum	93	0.0039	42	0.0	0.0	0.5952	1.7600	1.6820	1.9867
September									
Rock bass	58	0.0	18	0.0	...	...	...	...	...
Yellow perch	58	0.0172	18	0.0017	120.4897	0.4970	2.3800	1.4602	2.0031
Drum	58	0.0031	18	0.0017	10.8364	0.4970	2.3800	0.4032	2.0256
October									
Rock bass	22	0.0	4	0.0	...	...	...	...	...
Yellow perch	22	0.0835	4	0.0100	66.9451	0.2618	14.2000	2.0239	2.1623
Drum	22	0.0	4	0.0	...	...	...	...	...

* Significant at $\alpha = 0.05$.

Table 3. Catch rates for complete and incomplete angler trips with *t* and *F* statistics on Belleville Lake in 1977.

Month and species	Complete No.	Complete C/H	Incomplete No.	Incomplete C/H	F	Lower limit	Upper limit	Student t	$t_{0.05}$
April									
Bluegill	159	0.0749	241	0.0865	0.9180	1.0000	1.0000	0.3038	1.9693
Sunfish	159	0.0478	241	0.0167	18.9400	1.0000	1.0000	0.9410	1.9744
Crappie	159	0.5074	241	0.3178	3.7758	1.0000	1.0000	1.4835	1.9727
May									
Bluegill	186	0.0235	165	0.0903	0.1089	1.0000	1.0000	2.2357	1.9748*
Sunfish	186	0.0114	165	0.0313	0.3088	1.0000	1.0000	1.5339	1.9746
Crappie	186	0.2345	165	0.3138	0.7470	1.0000	1.0000	1.2353	1.9743
June									
Bluegill	47	0.0091	281	0.0190	0.1651	0.6944	1.5600	0.8141	1.9867
Sunfish	47	0.0033	281	0.0951	0.0008	0.6944	1.5600	2.3902	1.9603*
Crappie	47	0.0127	281	0.0043	3.7440	0.6944	1.5600	0.7537	2.0118
July									
Bluegill	39	0.0028	252	0.0045	0.2035	0.6757	1.6400	0.4286	1.9940
Sunfish	39	0.1230	252	0.2148	0.5624	0.6757	1.6400	0.8748	2.0079
Crappie	39	0.0051	252	0.0484	0.0105	0.6757	1.6400	2.1254	1.9638*
September									
Bluegill	26	0.3197	91	0.6922	0.7562	0.5495	2.0000	1.0169	1.9799
Sunfish	26	0.1868	91	0.1218	5.7643	0.5495	2.0000	0.3435	2.0561
Crappie	26	1.2021	91	0.6676	0.7981	0.5495	2.0000	1.0316	1.9799
October									
Bluegill	21	0.0079	73	0.1544	0.0129	0.5092	2.2300	3.8215	1.9984*
Sunfish	21	0.0992	73	0.1404	0.7500	0.5092	2.2300	0.4530	1.9867
Crappie	21	1.5193	73	0.9131	1.7091	0.5092	2.2300	0.8605	1.9867

* Significant at $\alpha = 0.05$.

Table 4. Catch rates for complete and incomplete angler trips with *t* and *F* statistics on Belleville Lake in 1976.

Month and species	Complete No.	Complete C/H	Incomplete No.	Incomplete C/H	F	Lower limit	Upper limit	Student t	$t_{0.05}$
June									
Bluegill	85	0.0121	18	0.0278	0.2943	0.5155	2.2900	0.5481	2.1029
Sunfish	85	0.0374	18	0.0	0.0	0.5155	2.2900	1.5309	1.9901
Crappie	85	0.0471	18	0.0	0.0	0.5155	2.2900	0.9991	1.9901
August									
Bluegill	49	0.0074	7	0.0	0.0	0.3922	4.2800	1.0029	2.0086
Sunfish	49	0.0121	7	0.0	0.0	0.3922	4.2800	1.1708	2.0086
Crappie	49	0.1307	7	0.0	0.0	0.3922	4.2800	1.1046	2.0086

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