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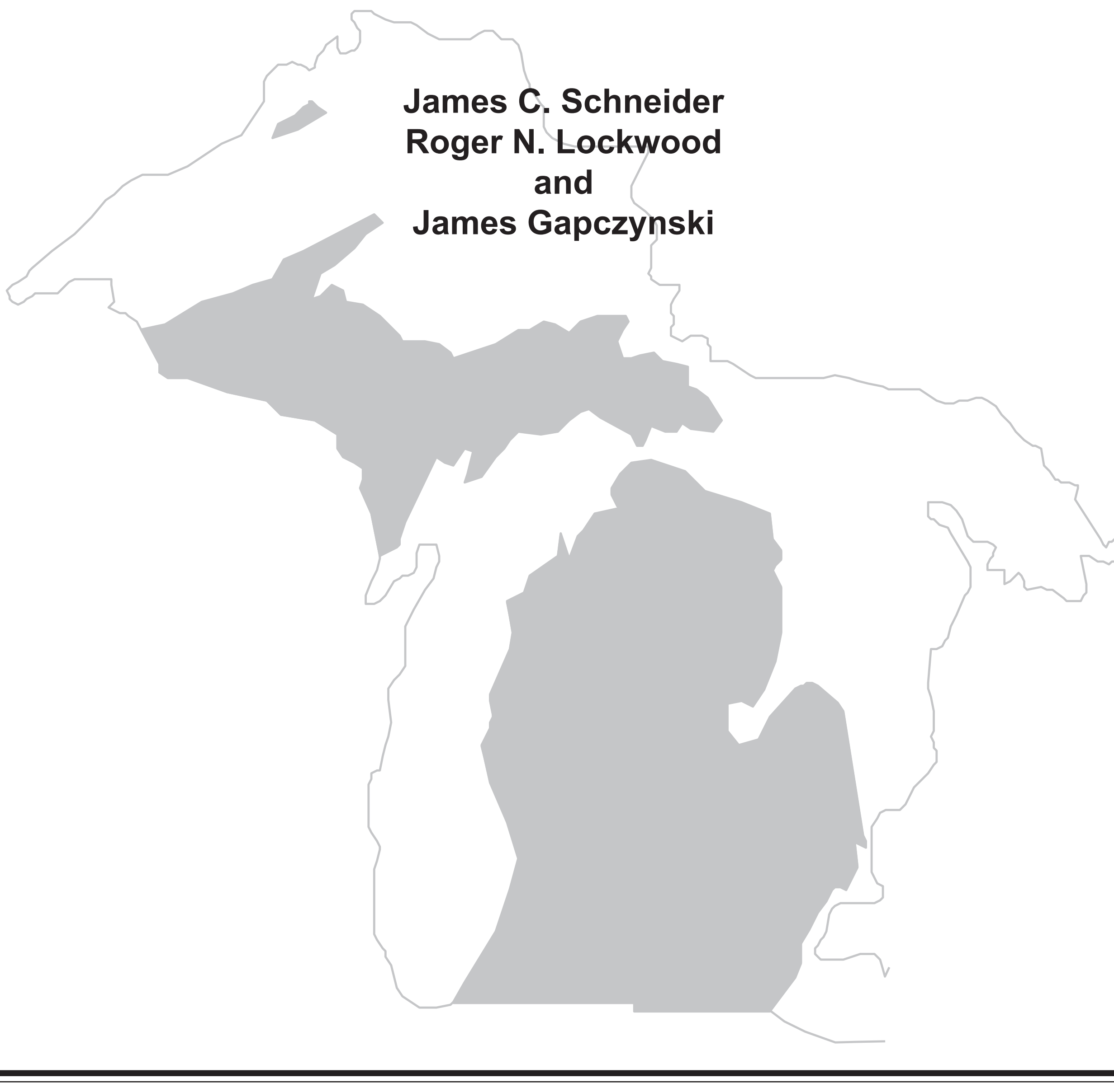

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Estimating Winter Lake Angling Pressure from Ice Holes

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Abstract.–We evaluated the potential of using counts of old ice fishing holes to estimate winter angling effort with studies at one pond and three lakes. The pond study measured the ability to detect known numbers of previously augered holes. All (10/10) pond auger holes were found after 20 days and 30% (3/10) of them were found after 49 days. In addition, one false hole was counted. For all holes augered within a 49-day period, 65% (13/20) were correctly identified. We suggest that under lake conditions the identification rate is likely to approximate 50%. Consequently, the method is probably most effective for estimating fishing effort on a relative or categorical scale, such as none, low, medium, or high. The lake study was conducted to obtain an index of winter angling activity on three small inland lakes closed to fish harvest. Lake hole counts indicated greater than expected angling activity.

Estimating angling pressure (activity) on a given lake is essential to understanding the dynamics of the fish population, quality of fishing, and success of fisheries management. However, it can be a difficult, time consuming, and expensive process.

Five methods have been commonly used for estimating fishing pressure:

1. Complete census for an entire season or year. All anglers are compelled to register when accessing a lake or river, and to report effort and catch when exiting. Total pressure is precisely the sum of their reports, possibly with a slight under-estimation due to non-reporting. This method has been used at a few state-owned areas, such as the Rifle River and Hunt Creek research stations, where access could be tightly controlled (Shetter 1939).

2. Roving surveys. Snapshot counts of anglers, fishing boats, occupied ice shanties, or units representing anglers (e.g., cars or boat trailers at launch sites) are made at randomly selected days and times from vantage points in an airplane or on the ground. The mean of these counts is then expanded to estimate effort during some period (e.g., weekdays within a month). When not all of the counted units may be associated with anglers fishing at the adjacent lake or river, both angling and non-angling parties are interviewed. Then, estimated angling effort is the product of total effort and proportion of angling parties in the interview data set (Lockwood et al. 1999). Between-day variation may be measured when one count per day is made, while both between-day and within-day variation may be measured when multiple counts per day are made (Lockwood et al. 1999). Numerous variations on this technique exist, such as the bus route method (Pollock et al. 1994) and roving surveys using proportional count method (McNeish and Trial 1991; Lockwood et al. 2001).

3. Access surveys. All anglers exiting a fishery over a period of time are interviewed. Their collective fishing effort (and catch) is then expanded over a broader time period (Hayne 1991). For example, if angling information were collected for 8 hours, then doubling the collective hours fished would give an estimate for angler hours (effort) over a 16-hour period. A variation on this method is used with Great Lakes angler surveys in Michigan. Here boats leaving a port are counted for some period of time (typically 0.5 h). Counts are then expanded by number of count periods within a survey day and mean length of boating trips (Fabrizio et al. 1991; Lockwood et al. 1999). Similar to Method 2, this method requires sampling of randomly selected days and time periods. This method is appropriate when anglers must pass through a specific point to access and exit a fishery.

4. Mail or telephone surveys. Random or stratified samples of anglers are interviewed by mail or telephone and asked to recall location, frequency, and duration of previous fishing trips (Pollock et al. 1994). This method is usually not suitable for lakes receiving relatively little angling due to their low probability of being sampled.

5. Voluntary survey. Anglers volunteer information by means of diaries, interview forms distributed on-site, or interview forms compiled by sporting good stores, resorts, or other cooperators. The reliability and comprehensiveness of these data are always suspect, and sometimes considerable effort is needed to gather and interpret these data (Pollock et al. 1994; Lockwood 2000). Reliability of these data is uncertain since the probability of an angler (or angling party) being sampled is not known and cannot be estimated.

Methods for estimating angling effort and catch using methods 2 and 3 are described in detail in Lockwood et al. (1999), Lockwood et al. (2001), Hayne (1991), and Pollock et al. (1994). Methods 1, 2, and 3 are the most reliable, but are also very expensive (Pollock et al. 1994; Hayne 1991; Malvestuto 1983). Methods 1-4 provide unbiased estimates of effort and methods 1-3 reliable estimates of catch. All methods become less precise and less practical at lakes receiving relatively little fishing pressure.

A new method for estimating ice fishing effort

We suggest that counting old ice fishing holes could be a potentially inexpensive and useful indirect method of estimating ice-fishing pressure. The main premise is that the record of a winter's fishing activity may be adequately preserved in the ice cover. A secondary premise is that number of holes is correlated with angling effort. Interpretation would be more complicated if many holes were used repeatedly. So far as we know, extrapolation of angling pressure from counts of ice fishing holes has not previously been evaluated.

Potential advantages of this method over the five traditional methods given above are:

- Lower cost;
- Even very low fishing activity might be detected;
- A single trip to a lake in late winter might give an estimate of the entire winter's fishing effort;
- Estimation efficiency could be enhanced by concentrating sampling effort in those areas of the lake most likely to have been fished (stratified sampling).

The method requires that:

1. All old holes, or a predictable percentage, can be found and recognized with minimal effort. Considerations are:
    - Type of ice cutting tool. Augers leave perfectly smooth and symmetrical holes that are easier to recognize than irregular ice spud holes.
    - Variations in hole appearance. Variations could be due to age, runoff, snow, and repeated freezing.
    - Size of hole. Augers 4-, 6-, and 8-inches in diameter are used, with the 6-inch the most common size.

Small holes are more difficult to find; large holes (e.g., made for shanty fishing) are easier to find.

- False ice holes ("mimics"). These are caused by surface water drainage, or melting around leaves or other objects.
- Snow cover. This may hide holes.

2. A predictable relationship between number of holes and number of anglers (effort) can be established. Considerations are:
   - Average number of holes made per angler per trip.
   - Reuse of existing holes versus making new holes. Fewer new holes are made if the weather stays above freezing; auger users tend to make new holes rather than re-open old holes.
   - Changes in the relationship might occur. Changes could be related to ice thickness, and to the gradual conversion from ice spuds to hand augers to power augers. In the last decade, use of the spud has greatly diminished except in spearing shanties.
3. As a final step, an estimate of angling hours could be made based on the average length of an angler trip. Existing averages from other types of winter angler surveys could be used for this step.

Potentially, three levels of fishing pressure information could be derived from the hole counts. First, the relative number of old holes alone could provide a rough indication of fishing activity on a relative scale of none, low, medium, or high. A quantitative refinement could be made by estimating number of holes per acre, and comparing that statistic across lakes. Eventually, averages could be established for lakes. Second, number of holes combined with an estimate of number of holes made per angler trip. Third, estimated angler trips per winter combined with an estimate of the average length of an angler trip could provide an estimate of angler hours per winter. Such estimates of angler trips per winter and angler hours per winter could then be directly compared to estimates obtained by traditional survey methods.

Conceivably, in a final step, estimates of the number of fish caught could be based on the above estimates of fishing pressure. However, a priori, we suspect that catch is not so strongly correlated with pressure as to be reliable, and additional interview data would be needed to estimate catch rate by species. Similarly, Ryckman and Lockwood (1985) showed that total harvest (a function of effort and catch rate) was related to duration of ice cover.

This report describes a small pond experiment conducted to determine the ability to recognize and accurately count old holes in a controlled setting, the crucial first step in evaluating this method of estimating winter fishing activity. The objective of the pond experiment was to determine the success rate for locating and recognizing old holes. We also describe the application of the method to estimating relative fishing effort at three small lakes.

Methods

Pond

A total of 20 holes were drilled in the ice of Pond 18 at the Saline Fisheries Research Station on January 3 and February 1, 1996 by one person (Table 1). A 6-inch auger was used to drill the holes in an unpredictable pattern across the 0.5-acre pond. All ice chips were skimmed from each hole, as an angler would do. Number and location of holes were recorded on a map and kept secret.

On February 21, when the ice was free of snow and ice visibility was good, a second person systematically walked transects 5-feet apart and tallied the number and location of recognizable holes (Table 1). The primary criteria for recognizing an auger hole were differences in appearance from background ice, approximate size, and a smooth circular outline.

A follow-up survey was made by the first person to evaluate which holes were missed and why. Photographs were taken of some holes for illustration (Figure 1).

Lakes

Field tests of the hole counting method were made at three small lakes being evaluated for the effects of antimycin treatments plus catch-and-release regulations on fish populations (Schneider and Lockwood 1997). Survey transects were made at 5-10 foot intervals during late-winter ice.

Results

Pond

A total of 13 out of the 20 auger holes (65%) were found and recognized by the second person while walking transects on February 21 (Table 1). In addition, one "mimic" hole (naturally caused) was tabulated as a questionable auger hole. Thus, the net error was an underestimate of holes drilled by 30% ([20-14]/20).

The second person found all (100%) of the 20-day old auger holes but only 30% of the 49-day old auger holes. However, the follow-up survey by the first person indicated two additional holes were very visible and had simply been overlooked during the systematic search. The remaining five holes were found with more diligent searching at their known locations.

It was observed that holes which had been cut in milky ice (slushy due to air bubbles or melted snow content) were very visible because the fresh hole closed over with clear water and ice, providing a strong contrast (Figure 1a). Strong contrast was also provided by milky holes (due to closing in with slush) cut in clear ice (Figure 1b). Clear holes cut in clear ice were the most difficult to see (Figure 1c). The old holes retained their original diameter of 6 inches.

Lakes

The counts ranged from 1.0 to 4.7 per acre (Table 2), suggestive that a significant amount of fishing had occurred overwinter. Counts were completed in a couple hours per lake. The numbers of holes actually made by anglers on each lake were not known; consequently, our efficiency at finding holes on the lakes is unknown. We suspect our efficiency was on the order of 50%.

Discussion

These studies demonstrated that the hole counting method has potential as an indicator of winter fishing activity. Auger holes as old as 49 days could be found and recognized. Thus, it appears feasible to find traces of an entire ice fishing season just before spring ice-out. The length of the winter fishing season varies annually according to weather. Southern Michigan lakes rarely have fishable ice longer than from December 25 to April 1 (95 days, more typically 65 days). In northern Michigan, the maximum is about 120 days (more typically 90 days). If further experimentation indicates a large error in hole recognition is caused by long periods of hole aging, an option is to search only for early-season holes during mid-January thaws that clear the ice of snow cover.

The main difficulty with the hole counting method is that an average observer during the late winter survey will not spot all old holes. To some extent, this systematic underestimate is offset by falsely classifying mimics as angling holes. For the pond experiment, where the net error rate was 30%, the true-hole count can be calculated as observed count x 1.43. Perhaps a reasonable expectation for lake conditions is that 50% of the old holes will be found within a search area of a typical lake.

Complete examination of lake surfaces may be impractical. A higher count error would likely occur for an entire lake survey because it is more difficult to walk transects uniformly spaced 5-feet apart and fatigue sets in. However, winter fishing activity is typically concentrated in relatively small, well-known areas of each lake. Such areas should be subsampled more intensively.

Since the harvest of all fish from our 3 lakes was prohibited, we anticipated that winter angling would be very light and finding many holes might indicate poaching was taking place. Possibly all activity was catch-and-release fishing, but more likely some illegal harvesting was occurring as well. These data prompted closure of the lakes to all types of winter fishing.

Conclusions

1. Old ice fishing holes were recognizable in pond ice for at least 49 days.
2. It is likely that many, perhaps most holes made early in the ice fishing season would be recognizable in late winter hole surveys.
3. Some old holes were overlooked during hole surveys. The net efficiency (holes missed plus mimics counted) was 70% for a pond surveyed with 5-foot transects. Efficiency on lakes is expected to be less, probably on the order of 50%.
4. The method of counting ice holes in late winter provided a useful relative index of winter fishing activity at three small lakes.
5. The method appears to be most suitable for determining relative fishing pressure, and annual trends, at small lakes that receive relatively low to moderate amounts of winter activity.
6. Possibilities for refinement of the method include establishing an average hole count for lakes to serve as a standard, and relating hole counts to other measures of fishing pressure such as angler trips and angler hours.

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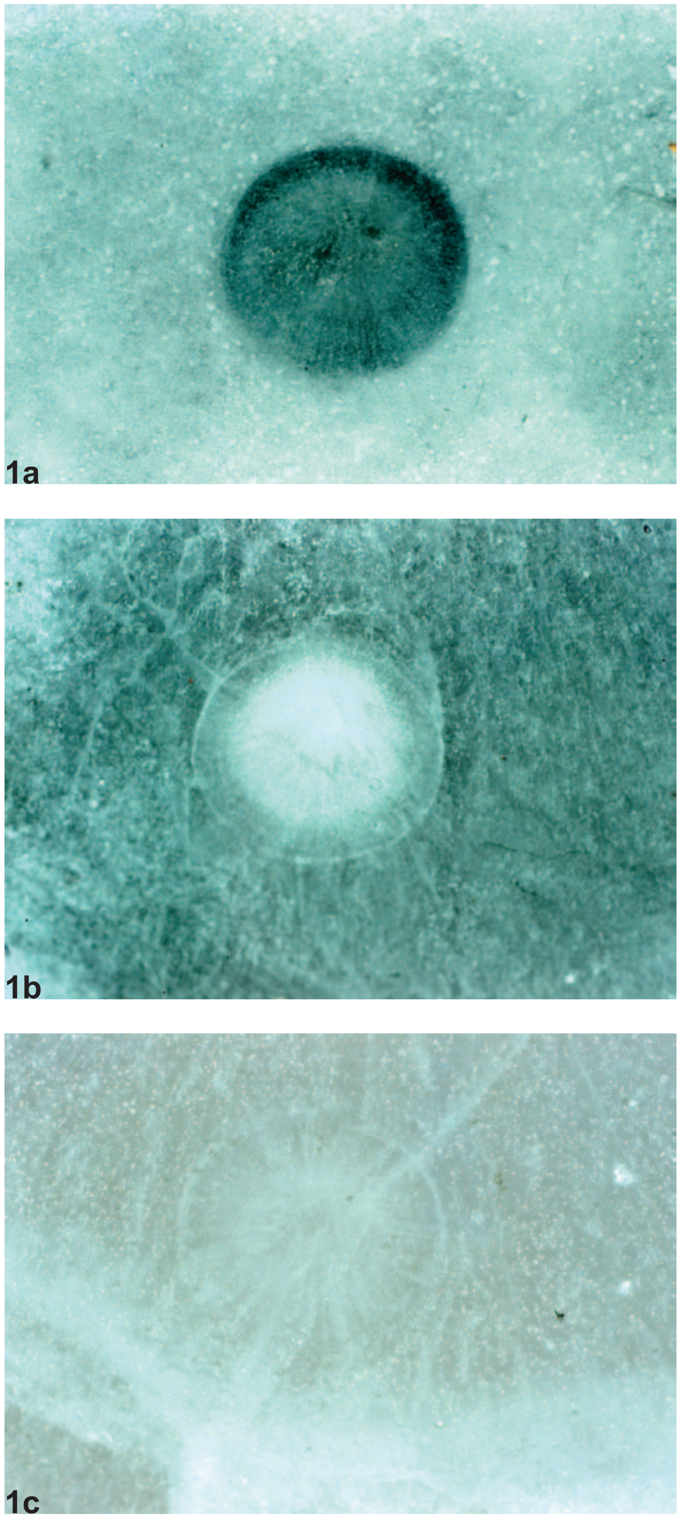

Figure 1.–Six-inch auger holes cut in milky ice and refrozen with clear ice (1a), cut in clear ice and refrozen with slushy ice (1b), and cut in clear ice and refrozen with clear ice (1c).

Table 1.–Data from the 1996 Saline pond experiment on ice holes.

Date	Ice thickness (inches)	Number of new holes augered	Old holes found Feb 21
January 3	5.5	10	3 (30%)
February 1	8.5	10	10 (100%)
Total		20	13 (65%)

Table 2.–Number of ice fishing holes observed at three lakes for samples in three winters, 1992-1995

Date	Williams Lake 18 acres	Horseshoe Lake 85 acres	Algoe Lake 16 acres
March 26, 1992			34
March 1992		97	
March 26, 1993		24	
March 29, 1993	85		
March 9, 1994		146	87
Average/acre	4.7	1.0	3.8

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