

Manual of Fisheries Survey Methods II: with periodic updates

Chapter 11: Instructions for Winter Lake Mapping

Clarence M. Taube

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Chapter 11: Instructions for Winter Lake Mapping

Clarence M. Taube

[Editor's note: This chapter records methods used by the Institute for Fisheries Research from approximately 1940 to 1970, when many public lakes in Michigan were mapped.]

This memo outlines the standards for lake maps and is intended to help the less experienced technician. It will bypass those techniques with which the crew leader should already be familiar.

Because the Fisheries Division does most mapping by the baseline-grid system on frozen lakes, the discussion will point toward this method, but comments generally apply to other methods.

11.1 Equipment

A check list of equipment and supplies is given in the following table. Although this list applies specifically to winter work, most of the items are also used in other methods.

11.1.1 Check list of lake mapping equipment and supplies

Car	Shovel	Leveling rod
Sled and riggings	Ice creepers	Level, line
Ice drill	Yard stick (or 6-foot steel tape)	Chalk line
Augers (2, for drill)	Ruler (12-inch plain)	Spikes (8-in, for bench marks)
Oil can	Ruler (12-inch engineer 's triangular)	Hammer, heavy
Batteries, storage (2)	Stationery and postage	Cold chisel
Battery charger	Clipboard	Wrench, Allen
Battery cables (2 extra)	Map paper	Pliers
Battery strap	Gridded work sheets (8 1/2- x 11-in)	Axe
Hydrometer	Lake Mapping Record forms	Pencils, #3 or #4 lead
Ice spud	Road map (state)	Pencils, #2 lead
Plane table and tripod	Map book (county)	Erasers
Compass	Directory (Department personnel)	Paper clips
Alidade	Personnel forms (Time & Attendance, etc.)	Rubber bands
Alidade, right-angle, with tripod	Diaries	Thumb tacks
Cables, 100-ft. measuring, with reels (2)	Note books	Masking tape
Cables, 100-ft. sounding, with reels (2)	Scratch paper	Instructions memo
Sounding weights (2)	Mailing tubes	
Level, surveyor's, with tripod	Parcel post labels	

Below are precautions that apply to the care and use of the battery-powered ice drill:

1. Keep the bit or auger covered with the protective block when the drill is not in actual use.
2. Two sets of small set screws on the shaft of the drill must be kept tight with an Allen wrench to guard against loss of the auger.
3. Drilling should be done with the drill perpendicular to the ice; the auger may be bent while drilling at an angle.
4. Do not use the drill in very shallow water where the auger can be ruined by stones or frozen earth; use a spud over very shallow places.

For lake sounding, the advantage of the drill is the time it saves on thick ice. Spudding is more efficient on relatively thin ice (to about 4-6 inches thick).

Mapping data should be recorded on standard map paper, 22 inches x 34 inches, which is gridded with either 1/3-inch or 1/2-inch square divisions to assist with measurements. Sometimes the paper has shrunk so that the divisions are reduced in size. In this case, allowances must be made for the shrinkage when using the grid for measurements. With regard to soundings, there are two alternatives: (1) the recorder measures distances between sounding locations on the map, rather than determining them with the printed grid, or (2) the actual distances between soundings are reduced to match the grid on the shrunken paper (e.g., if the map shrinkage amounts to 2% and if soundings were to be made at 200-foot intervals, the interval to be measured on the ice should be reduced to 196 feet).

Gridded 8 1/2-inch x 11-inch work sheets are provided for convenience in plotting the shoreline, especially on large lakes. Sections of shoreline may be sketched on these sheets then transferred to the larger field map, eliminating repeated transport of the larger map between baseline and shore.

11.2 Mapping Procedure

11.2.1 Access to lakes

Lakes are classed as follows based on ownership and access:

- **Public lakes.**—Some publicly owned frontage, such as county park, public fishing site, state or federal land, etc.
- **Semi-public lakes.**—Either: (a) shores are entirely owned by private interests, but the public is allowed to fish without charge; (b) have boat liveryes; or (c) have navigable inlets or outlets that lead to public access sites.
- **Private lakes.**—The public is excluded or charged a fee for access.

Any public lake may be mapped. Semi-public lakes usually are mapped, but should not be mapped if there are clear indications that public fishing is likely to be prohibited in the near future. Private lakes should not be mapped, except in special instances, or on a consulting basis at private expense.

11.2.2 Lake outline

The map should be planned so the north direction will be located somewhere within the top half of the sheet. Symbols, legend, sounding data, etc., are to be entered parallel with the top border. Choose a scale which will allow the lake outline to fill a large part of the sheet, but which will also allow ample room for shore features, the heading, and legend. One of the following scales (feet to 1 inch) should be used: 25, 50, 75, 100, 150, 200, 300, 400, 600, 800, 1000, or 1200. A feature sometimes overlooked is that of encroaching shore. This type of shoreline borders wetland areas where the lake's edge is not clearly defined. Indication of encroaching shore on lake maps can be very helpful to fisheries workers and people who are buying frontage.

11.2.3 Soundings

The spacing of soundings has an important bearing on both mapping accuracy and speed. Insufficiency of depth records may result in an inaccurate map, or one that does not give adequate information for management. On the other hand, over-intensive sounding wastes time and effort. It is difficult to prescribe a definite pattern for spacing depth measurements because of the variability of lake basins. Good decisions on how frequently soundings should be made increases with experience. The following is a general guide relating lake acreage to sounding interval when mapping is done on ice: 5-acre lakes – 50-foot intervals; 10-25 acres – 100 foot; 50-300 acres – 200 foot; larger lakes – 300- to 400-foot intervals. Additional soundings are often necessary between shore and the drop-off, in and around shoal areas that occur well out from shore in some

fairly deep lakes, and throughout the basins of lakes in which depths are highly variable. Incompleteness of depth data may become evident as a set pattern of sounding is in progress; in such cases additional measurements should be made in the questionable area.

11.2.4 Substrate

Soft bottom can cause significant errors in depth measurements. The bottom may be so soft that the sounding weight passes through it almost as freely as water. In such areas sounding must be done with extreme care, and the cup which collects bottom materials should be inspected often to determine the top level of the deposits. After some experience, one acquires a "feel" for the difference in descent of the weight through water and through very soft bottom, which helps greatly in locating the boundary between the two strata.

A cup is attached to the lower end of the sounding weight to retain a sample of the bottom deposit when a depth is measured. The type of deposit present at each measuring site is determined, and is recorded on the map with the depth figure (e.g., 4-S, 10-M, etc). If goodly quantities of two soils occur together in a sample, indicate the presence of both, listing the key letter of the predominant type first. Below is the classification of bottom deposits currently in use for lake maps, including key letters and symbols used on completed maps to show the distribution of each material:

Organic - O	Gravel - 
Marl - M	Rocks - 
Sand - S	Bed Rock - BR

The physical characteristics and usual locations of these materials are:

Organic.—Consists of decomposed or partially decomposed parts of plants. It may have any of a variety of colors, and generally has a smooth texture but often contains plant fibers. This is the most prevalent deposit of deep areas, but organic materials may also occur in shallow locations.

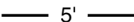
Marl.—Gray in color, often gritty, pieces of snail or clam shells frequently included. This deposit may sometimes be mistaken for clay, especially if smoothly textured. When hydrochloric acid is dropped on a questionable sample, boiling action will ensue if it is marl, but not if it is clay. This is a fairly common lake soil, which may be found in either shallow or deep places.

Sand, gravel, rocks, bed rock.—Classification is based on particle size, with rock defined as having a diameter greater than 3 inches. These materials are largely confined to wind-swept shoals of inland lakes. If present in deeper waters, they are usually deeply covered with finer sediments and will not be detected. Superficial gravel and rock deposits will not be sampled by the cup, but noises or vibrations during depth sounding may indicate their presence.

11.2.5 Shore features

The sample legend on the next page illustrates features and symbols used on our lake maps.

Legend

Bottom		Shore features	
O	Organic		Improved road (applying to gravel or pavement)
M	Marl		Unimproved road
S	Sand		Trail (foot trail, not passable for cars)
	Gravel		Railroad
	Rocks		Bridge
BR	Bed rock	Culvert (no symbol; use word "culvert" with arrow to show location)	
	Deadheads (or snags)		Building (if public or semi-public, also designated as "Hotel," "Store," etc.)
	Stumps		Boathouse
	Brush shelter		Dock
	Trash		Steep slope (use in series, showing course of formation)
Outline and Contours			Wooded
	Shoreline		Partly wooded
	Encroaching shore		Pasture (or cleared land)
	Breakwater		Cultivated land
	Contours		Brush
			Marsh
			Spring
			Inlet
			Intermittent inlet
			Outlet
			Intermittent outlet
			Dam
			Beaver dam
			Beaver house
			Bench mark

11.2.6 Legend

Formerly, it was customary to show on maps all buildings present on lake shores. This practice was discontinued because it was often impractical to show all homes or cottages, and on some lakes continuous building activity causes those map features to become quickly outdated. However, for the sake of orientation, prominent structures (hotels, isolated homes, etc.) should be included. Leave out boat docks unless they are substantially constructed, but include boat houses.

Public fishing sites are to be shown (with boundaries, if conveniently possible), as are the locations of other public frontage and semi-public establishments (boat liveries, Boy Scout camps, etc.). Buildings associated with such developments need not be plotted.

Roads and trails near the lake should be included. Their widths are not drawn to scale, but their distance from the shoreline should be to scale, and their compass directions true. Record the names or numbers of designated roadways.

11.2.7 Bench marks

Bench marks are established for measuring lake level fluctuations. They can be very useful. Trees, bridge or dam abutments, and concrete foundations are among the objects that may serve as bench mark monuments. Spikes serve as reference points in trees, and a cold chisel is used to etch concrete or steel objects. Measurements of water elevations are made with either a surveyor's level and leveling rod, or a line level, chalk line, and leveling rod. Plainly record elevation, location, and establishment date for each bench mark on the field map. Bench marks should be established at the time the lake is mapped so that those data can be included on the finished map.

Our system of presenting water level data assigns the figure 100 as the level of the bench mark. The lake level reading appears as the difference between this figure and the distance in feet that the lake surface lies below the bench mark. For example, if the water surface is 3.8 feet lower than the bench mark at the time of mapping the lake surface is 96.2, which is simply 100 minus 3.8.

The vertical measurements for level determinations should be recorded on the field map. Following is a sample computation from measurements made with a surveyor's level and leveling rod:

Rod reading above water level	6.78 feet
Rod reading above bench mark	<u>-2.64 feet</u>
Bench mark above water level	4.14 feet

$100.00 - 4.14 = 95.86 = \text{water surface elevation}$
(rounded off to 95.9 on the drafted map)

The computation is simpler if a line level is used: subtract from 100 the height above the lake surface that the leveled chalk line meets the measuring rod. This equipment is adequate if the bench mark is near the edge of the lake (within 50 feet or so). Surveyor's equipment is better when the bench mark is some distance from the lake, and it may be used in all situations.

Occasionally, a bench mark may be higher above the lake than the maximum height of the leveling rod. In such situations, it is necessary to make the level determination in successive steps from the bench mark to the lake, resetting the rod and adding the successive heights.

Below are cautions and guidelines for bench mark procedures:

1. Be sure you are thoroughly familiar with level determination methods. The data are of no value if inaccurate. If a line level is used, place it on the chalk line approximately midway between the bench mark and the rod or pole at the other end.

2. Place the bench mark higher than the estimated maximum level of the lake. When a tree is chosen as a monument, drive the spike in near the base of the trunk, leaving at least 3 inches of the spike exposed.
3. Try to establish three bench marks at each lake that is mapped. Formerly, establishment of one monument was standard procedure, but the loss of the bench mark at some lakes has pointed up the need for more than one.
4. Try to space bench marks widely apart to insure against loss of all of them.
5. If public frontage is available, locate at least one of the bench marks there. Avoid yards of homes as locations.
6. If possible, do not place bench marks in willows, poplars, or birches because these trees are short-lived and deteriorate rapidly after death. Elms should be bypassed because of the prevalence of Dutch elm disease. At some lakes, however, scarcity of suitable objects for monuments permits little choice.

Agencies other than the Fisheries Division have established bench marks at some lakes. In some instances, you will be informed if a bench mark exists for lakes on your mapping schedule. If a bench mark has already been provided for a lake that is to be mapped, its location, a new level determination made from it, and its original level data are to be included on your map. New level readings obtained from these previously established references should be expressed in the terms of the original data, which are usually based on sea level.

Mapping crews may be asked to set up additional bench marks for lakes that have been mapped and which have a Fish Division bench mark. In such instances, it is always necessary to obtain a water level reading from the original bench mark the same day the new reference points are installed.

11.3 Completing the map

11.3.1 Depth contours

Contours are drawn after depth sounding has been completed. It is advisable to draw contours while the crew is still in the vicinity of the lake in case additional soundings are needed.

Ordinarily, contours are drawn at 5-foot intervals to depths of 20 feet, and at 10-foot intervals beyond 20 feet. Exceptions are: (1) situations in which all or most of a lake is less than 5 feet deep (either 2-foot contour intervals or no contours may be appropriate), and (2) lakes in which the declivity is too abrupt to permit drawing contours with intervals of less than 10 feet (but plot the 5-foot contour if at all possible).

Contours should be drawn with smoothed curves. Where a recorded depth is identical to a contour interval, carry the line a little *to the deeper side* of the sounding location rather than through it. Where several equal depths occur successively in a shore-to-deepwater direction, draw the contour near the middle of the series.

Contours naturally tend to parallel each other. Therefore, be suspicious of depth data if contours deviate markedly from this tendency.

Too few soundings or erroneous records can cause marked variation in contour placement. Verify suspicious data and take additional soundings, as needed, while still on the lake.

11.3.2 Bottom soils

Indicate bottom soil types by symbol, as listed previously. If only one kind of soil was found over the whole lake, a note on this fact is sufficient (e.g., "The entire bottom is organic"). If one or more types are associated with another type that strongly predominates, indicate the predominant type by symbol and the subordinate types by notation.

11.3.3 Miscellaneous data

Other data that need to be recorded on the field map are: name(s) of the lake; location as to township, range, and section (to quarter section if there is a chance the lake can be confused with another in the same section); names of the persons who did the mapping; dates spent on the job; and scale. *Be sure to record the scale which actually applies to the lake*, and not one you had intended to use but discarded later, or one (not applicable to this map) unintentionally carried over from another map.

Printed forms (the Lake Mapping Record) are provided for entry of certain kinds of information about lakes. This record is to be prepared for each lake that is mapped, and should also be filled out (as completely as available information will allow) for a lake that was visited but not mapped.

Send field maps to the drafting office periodically rather than submitting all of them at one time at the end of the work season. This practice will permit more orderly final drafting, and should clarification of work be required, it usually can be done best soon after a map has been drawn.

Written 12/1960 by C. M. Taube
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