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SALT METHOD FOR DETERMINING POND VOLUME

By

William C. Provine

Austin, Texas

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ABSTRACT

Present methods of determining pond volume are time-consuming and laborious. This paper describes a simple, rapid method for determining water volume in ponds by measuring the change in chloride concentration caused by the addition of a known weight of salt. Mean volume estimates derived by this method were not significantly different (*F*-test; 0.01 level) from those obtained by multiplying surface area by mean depth or measuring the flow rate through fill pipes.

SALT METHOD

FOR DETERMINING POND VOLUME

William C. Provine

Texas Parks and Wildlife Department

Houston, Texas 77044

In fishery research and management it is often necessary to know the volume of water in a pond or small lake. A major factor hindering the successful use of chemicals in such waters is the absence of a fast, dependable method for determing water volume. In this study I compare a salt method of pond volume determination with two other commonly used methods in terms of reliability, labor requirements, and costs.

MATERIALS AND METHODS

The volume determination study was conducted on six 0.4- to 0.7-acre rectangular hatchery ponds at the Sheldon (Texas) State Fish Hatchery. The mean and maximum depths of these ponds ranged from 1.5 to 1.8 ft and 4.0 to 5.5 ft, respectively. Thermal stratification did not occur during the study. The ponds contained no aquatic vegetation and few fishes. Other physicochemical characteristics are given in Table 1.

Pond volumes were obtained by measuring the change in chloride concentration 1 day after an uniodized salt solution was applied to the experimental ponds. To compare application techniques I dissolved 100 lb of salt in 200 gal of water and sprayed the solution on the nearshore waters of one pond and evenly over the surface of another pond. Analyses of water samples the following day showed the chloride concentration to be homogeneous in each of the ponds. Since the

Table 1. Physicochemical characteristics of six hatchery ponds used in the study of pond volume. All observations were made within the upper 1 ft except temperature, which was taken at 1-ft intervals.

Pond No.	Average temperature (°F)	Turbidity (JTU)	pH	Total alkalinity (ppm $CaCO_3$)	Total hardness (ppm $CaCO_3$)	Chloride (ppm Cl^-)
1	67.1	20	6.8	40	50	15.0
2	67.1	20	6.8	45	50	15.0
3	54.0	120	7.2	--	205	12.5
4	54.0	120	7.2	--	205	12.5
5	85.0	140	7.3	37	30	10.0
6	86.0	140	7.4	37	20	10.0

nearshore treatment took only one-eighth of the time required by the surface treatment, I used this procedure in the study. "Ranch House" brand feed-mixing salt, obtained from United Salt Corporation,[1/] Houston, Texas, was used (see analysis, Table 2). Chloride concentration was measured by mercuric nitrate titration. Pond volume was calculated by the following formula:

$$V = W/(C \times 2.718144)$$

where V is the volume of pond in acre-feet, W is the weight (in pounds) of added chlorides (from Table 2), and C is the change in concentration of Cl^- in ppm. Estimates of pond volume obtained by the salt method were compared with those found by two commonly used techniques. Volumes of four study ponds were calculated by multiplying mean depth by surface area. Two of these ponds were sectioned into grids (grid lines 10 ft apart) and depth measurements made at each grid intersection with a calibrated sounding line to determine mean depth; an alidade and plane table were then used to determine surface areas. Volumes of the remaining two study ponds were found by calculating water flow rates through fill pipes by the techniques described by Klontz (1973).

RESULTS AND DISCUSSION

Comparison of volume determination methods (Table 3) shows differences ranging from 0.22 to 9.40% (mean difference, 2.71%). Volume means estimated by the three methods were not statistically different (*F*-test, 0.01 level). Although one experiment resulted in a volume difference of 9.40%, differences

1/ Reference to trade names does not imply Government endorsement of commercial product.

Table 2. Analysis of feed-mixing salt (100 lb) used in the study of pond volume.

Substance	Percent	Weight of chloride (lb)
Sodium chloride	88.50	56.557
Calcium sulfate	0.61	
Calcium chloride	0.06	0.038
Magnesium chloride	0.01	0.007
Insoluble	10.74	
Moisture	0.08	
TOTAL	100.00	56.602

Table 3. Comparison of methods for determining pond volume (in acre-feet).

Pond No.	Pond Volume: Standard Method*	Pond Volume: Salt Method	Difference in Salt Method (%)
1	1.847	1.851	+0.22
2	1.625	1.665	+2.46
3	0.630	0.641	+1.75
4	0.766	0.694	-9.40
5	1.184	1.189	+0.42
6	1.062	1.041	-1.98

*Mean depth times area in ponds 1-4; flow rate through pipes in ponds 5 and 6.

in the remaining five comparisons did not exceed 2.46% (mean = 1.37%). The 9.40 value was probably a titration error, since one drop in titration could have caused a difference of this magnitude.

The salt solution used in this study apparently would have no detrimental effect on fishes. Addition of 100 lb of feed-mixing salt (56.602 lb Cl^-; Table 2) to 1 acre-ft of fresh water results in a chloride concentration of about 0.03 ppt. According to data from Allen and Avault (1969) this concentration is far below the tolerance level (8 ppt) of channel catfish (Ictalurus punctatus) immediately after hatching, which is the most sensitive state of development. It is also below the salinity levels at which channel catfish and blue catfish (I. furcatus) have been reported to spawn (Perry 1973); Perry also stated that the effects of salt water on the reproduction and survival of catfish tend to follow the same pattern as those reported for largemouth bass (Micropterus salmoides) and bluegill (Lepomis macrochirus). Lewis (1971) reported improved growth rate and food conversion and lower oxygen requirements in channel catfish cultured in waters containing 1.7 ppt sodium chloride. Allen and Avault (1970) reported that brackish water (1 to 9 ppt) was effective in controlling Ichthyophthirius and suggested that it might also be effective in controlling other freshwater parasites.

In this study the labor difference between methods for determining pond volumes -- mean depth times area (12 man-hours) and salt (1.5 man-hours) -- makes the salt procedure more desirable, at least in unstratified ponds. Labor required for the flow rate method was comparable with that for the salt method, but inconsistent flow rates (common in most hatchery situations) can cause large errors in volume determinations; usually this problem cannot easily be corrected.

The salt method demands special care. Chloride titrations should be performed until results are consistent. A 1-drop difference can cause a substantial error in volume estimates, depending on the salt concentration selected. Titration errors can be reduced, however, by increasing the salt concentration of the pond waters. Uniodized salt must be used for the salt method because iodide is titrated with mercuric nitrate in the same manner as chloride and may produce erroneous chloride readings (American Public Health Association 1965). Since the salt method may not be applicable in stratified ponds, temperature profiles should be checked before the procedure is used. In stratified ponds, volume determinations should be made during or just after the passing of cold fronts, while the water is mixing. If volume determinations must be made in advance of the anticipated treatment date, reference points maintained on the pond shoreline will help detect changes in volume.

Little effort and expense are required for the salt method. Although mechanical equipment can be used to facilitate the application of salt solutions, the salt can easily be applied by hand. The cost of a titration kit (available from scientific supply companies) is about $8.00. If salt is used at a rate of 67 lb/acre, the cost is about $2.00/acre-ft of water for this technique of volume determination.

CONCLUSION

The salt method is potentially useful for field application; cost, labor, and equipment requirements are low. Results of volume determination obtained by the salt method are comparable to those derived by surface area times mean depth and flow rate through fill pipes.

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