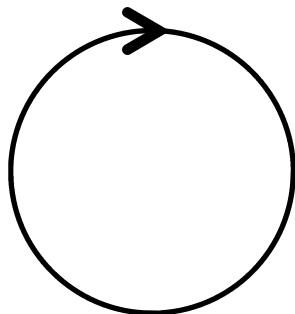




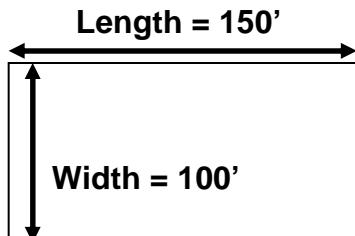
Pond Facts #4

Measuring Pond Area and Volume

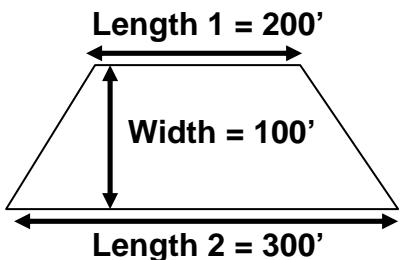
The importance of getting an accurate estimation of your pond surface area cannot be overestimated. The majority of pond owners visually estimate their pond area, which usually results in an overestimate of the true pond surface area. Pond area and water volume should be calculated based on some simple measurements. The effort necessary to estimate pond surface area is directly related to your pond's shape and uniformity. The simplest method—using basic equations for common shapes—can be applied if your pond closely resembles a circle, square, rectangle, or trapezoid in shape.



Circular pond shape can be estimated by measuring the distance around the pond shoreline in feet. Square the shoreline distance and divide by 547,390 to get the pond area in acres. For example, a pond that is 450 feet around the shoreline would have an area = $(450 \text{ feet})^2 / 547,390$ or 0.37 acres.



Rectangular or square shape area is estimated by simply measuring the length and width of the pond sides in feet. Multiply the length times the width to get the square feet of surface area. This value can be converted to acres by dividing by 43,560 ft²/acre. So, a pond that measures 150 feet long and 100 feet wide would have an area = 150 feet X 100 feet = 15,000 ft² or 0.34 acres.

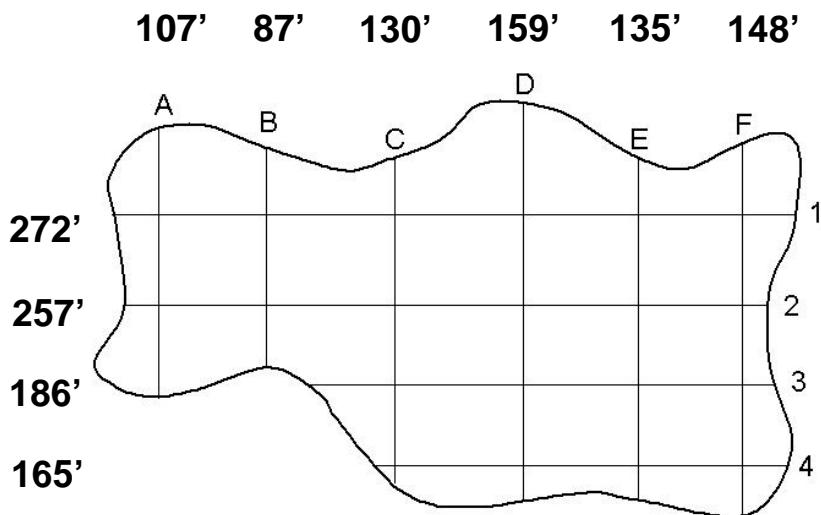


Trapezoid—Many ponds may be roughly rectangular in shape, but one side may be significantly shorter than the other. The area of this shape is best estimated using a formula for a trapezoid by taking the average length of the two unequal sides and multiplying by the width of the pond. For example, a pond that is 200 feet long on one side, 300 feet long on the opposite side, and 100 feet wide would have an area = 250 feet X 100 feet = 25,000 ft² or 0.57 acres.

Many ponds have an irregular shape where the surface area cannot be adequately estimated using the formulas for common geometric shapes. Three methods can be used in this case depending on the degree of accuracy you desire. Keep in mind that the accuracy of your pond surface area estimate may be very important, especially for the safe use of aquatic herbicides. The three methods are described in order from least to most accurate. You should strive to use the most accurate method that you can reasonably accomplish.

(1) Average Length and Width Method: Take numerous measurements to determine the average length and average width. Make certain you get both the longest and shortest distances in calculating the average length, and the widest and narrowest distances for determining the average width. The more measurements that you make, the more accurate your result will be. The area is then calculated by multiplying the average width times the average length. If you do your measurements in feet, your result will be in square feet. You can convert square feet into acres by dividing it by 43,560 ft² per acre. Depending on the number of width and length measurements made, the final area will probably be within about ± 20 percent of the actual pond surface area.

In the example below, the area of an odd-shaped pond is measured by taking six widths (Lines A–F) and four lengths (Lines 1–4).



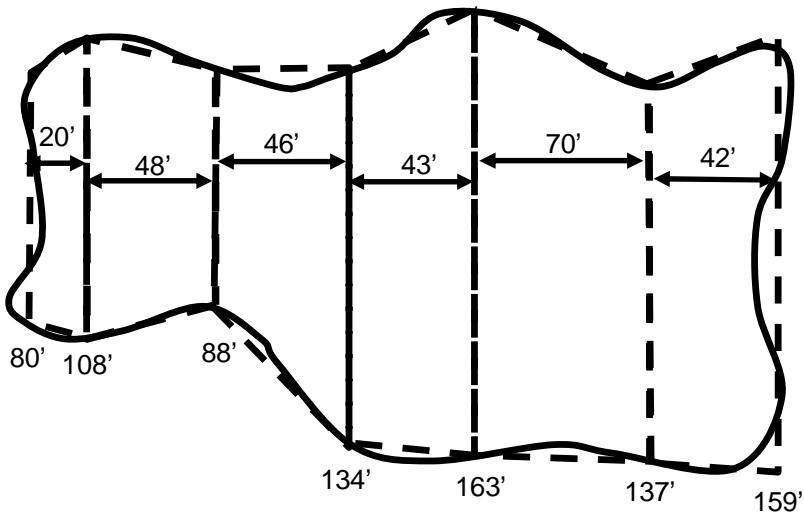
The average width is $(107' + 87' + 130' + 159' + 135' + 148') / 6 = 128$ feet

The average length is $(272' + 257' + 186' + 165') / 4 = 220$ feet

Therefore, the area of the pond can be estimated by multiplying the average width and length.

Surface area = 128 feet x 220 feet = 28,160 ft² or 0.65 acres

(2) Multiple Trapezoids Method: A more accurate method to determine the area of an odd-shaped pond is to divide the pond into multiple trapezoid shapes. A new trapezoid is defined anywhere the shoreline makes a rapid change in direction. The illustration on the opposite page shows the same pond from above divided into seven trapezoids (shown in dotted lines). Note that instead of horizontal transects, this method requires measurement of the distance between each vertical transect. This would be most easily done during winter when the pond is frozen and the transects could be easily laid out and measured. This method requires more measurement and effort, but the final area estimate will probably be within ± 5 to 10 percent of the actual pond area.



The individual trapezoid areas can be calculated from left to right as:

$$\begin{aligned} \text{Area 1} &= (80' + 108') / 2 \times 20' = 1,880 \text{ ft}^2 \\ \text{Area 2} &= (108' + 88') / 2 \times 48' = 4,704 \text{ ft}^2 \\ \text{Area 3} &= (88' + 134') / 2 \times 46' = 5,106 \text{ ft}^2 \\ \text{Area 4} &= (134' + 163') / 2 \times 43' = 6,386 \text{ ft}^2 \\ \text{Area 5} &= (163' + 137') / 2 \times 70' = 10,500 \text{ ft}^2 \\ \text{Area 6} &= (137' + 159') / 2 \times 42' = 6,216 \text{ ft}^2 \end{aligned}$$

Summing the trapezoid areas gives a total pond area of 34,792 ft² or about 0.80 acres.

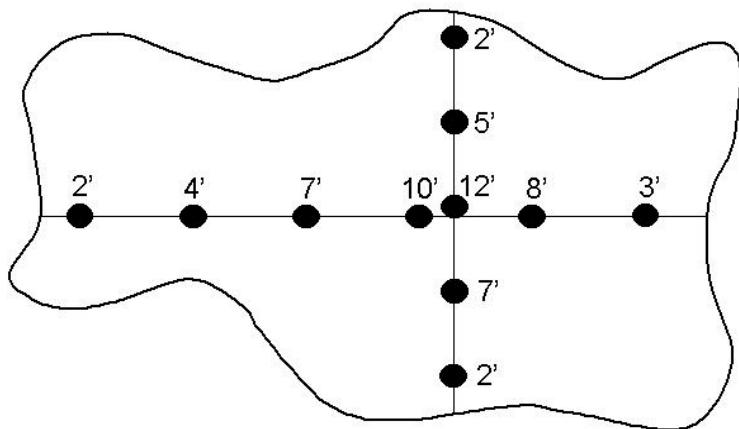
(3) Handheld Global Positioning Systems (GPS): Handheld GPS systems have become quite common over the past five years as they have become more affordable. They are now routinely used for outdoor recreation (hunting, hiking, camping, etc.) and navigation. GPS units allow you to determine your exact location on earth using multiple satellites in space. Various locations, or “waypoints,” can be stored in the GPS unit for use with mapping software that either accompanies the unit or can be purchased separately. The software can connect the waypoints and calculate the area inside the resulting shape.

A pond surface area could be estimated by walking the perimeter of the pond and stopping at various waypoint locations along the pond shoreline. If waypoints are stored at each location where the pond shape changes, the resulting area will be extremely accurate, probably within 1 percent of the actual pond area. Even if you do not own a GPS system, friends or family members that enjoy outdoor recreation may own a unit that could be used to estimate your pond surface area.

Pond Depth and Volume Measurement

The volume of water in ponds is often expressed in units called “acre-feet.” An acre-foot represents one surface acre that is one foot deep. To calculate the acre-feet of water in a pond, you’ll need the surface area in acres as calculated above and an average depth of water in the pond. For a typical bowl-shaped pond the average depth can be estimated as 0.4 times the maximum depth. So, a pond with a maximum depth of 12 feet would have an average depth of about 4.8 feet.

A more accurate method for calculating average depth is to make many measurements and calculate an average. This is most often done by measuring the pond depth along two transects—one along the width and one along the length. Make sure to pick transects that represent the shallow and deep portions of the pond. Depths can be measured easily from a canoe or boat using a weight and a string marked in feet. The more depth measures that you make, the more accurate your final average will be. In the example shown on the next page, pond depths were taken at six locations across the pond length and five locations across the pond width. The average pond depth can be calculated as the average of all of these measurements.



The average of the eleven depth measurements made in this example is 5.64 feet.

The volume of water in the pond (in acre-feet) is calculated by simply multiplying the pond area (0.80 acres using the trapezoid method) by the average pond depth in feet (5.64 feet). Thus, this pond has about 4.5 acre-feet of water. One acre-foot of water is equal to 325,851 gallons, so this pond is storing about 1.47 million gallons of water.

An even better way to calculate an average pond depth is to divide the pond into numerous (at least four) sub-areas (much like we did in the trapezoid method). Take at least one depth within each of the sub-areas and use these to calculate the overall average pond depth. This method is especially good if the pond bottom is irregular rather than bowl shaped.

A Final Word

Using the methods described in this fact sheet will allow you to calculate the surface area and volume of water in your pond with reasonable accuracy. These numbers are critical for the safe and proper use of various pond management activities such as using aquatic herbicides, liming, fish stocking, and using aeration devices.

Additional Resources

For further information and publications on pond management in Pennsylvania visit our Web page at:

www.sfr.cas.psu.edu/water

or contact your local cooperative extension office.

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