

## Calculating the Volume of a Lake Using ArcView 3.2

The following instruction set is meant to guide you through the five-step process of obtaining the volume of a lake, using ArcView and the appropriate extensions:

- A. Establish an ArcView project with appropriate extensions
- B. Create a theme for GPS points of depth measurements
- C. Convert lake boundary to points to overlay with depths
- D. Interpolate a continuous surface of lake depths
- E. Convert surface to a TIN to calculate volume

These instructions may be adapted for any application that involves the creation of a continuous surface within the extent of a polygon and subsequent conversion to a TIN, but apply specifically to generating a depth surface within a lake using a .dbf file of GPS point locations and a shapefile for the lake polygon. The example file names used here are:

### ORIGINAL DATA THEMES

<b>Depth.dbf</b>	a dBASE file containing x, y, and z information (i.e. Easting, Northing, Depth_inch)
<b>Lake.shp</b>	a shapefile of the digitized lake polygon

### CREATED DATA THEMES

<b>Lakepoints.shp</b>	a shapefile resulting from the polygon to points conversion
<b>Mergedpoints.shp</b>	a shapefile resulting from the overlay of Depth.shp and Lake.shp
<b>Lakegrid</b>	a grid resulting from the conversion of Lake.shp
<b>Lakedepths</b>	a grid resulting from the interpolation of Merged.shp
<b>Depthtin</b>	A TIN resulting from the conversion of Lakedepths

### ***A. Establish an ArcView Project and Activate Required Extensions***

When launching a new view in an ArcView project, it's always a good idea to set your map and distance units straight away, before adding themes.

1. Open ArcView and create a new project with a new View, but do not add data.
2. Highlight the View window
3. Choose FILE → SET WORKING DIRECTORY
4. Enter the path to where the data will be stored
5. Choose VIEW → PROPERTIES and set Map Units and Distance Units (e.g. meters, if your .dbf file of point locations are UTM coordinates)

6. Choose FILE → EXTENSIONS
7. Click on the check box next to the following extensions:
  - 3D Analyst**
  - Geoprocessing**
  - Poly conversion to spaced points (1.2)**
  - Spatial Analyst**
8. Click OK

## ***B. Create a Theme from the GPS Point Data***

Any new point theme based on a table of X, Y, and Z data can be created in this manner. In this case, Depth.dbf has Easting as the X-value, Northing as the Y-value, and Depth\_inch as the Z-value.

1. Highlight the Project window
2. Choose PROJECT → ADD TABLE from the Project menu
3. From the Add Table window navigate to the directory where your .dbf table file is stored
4. Choose the proper file type under List Files of Type: (e.g., \*.dbf)
5. Select your file and click OK
6. Highlight the View window
7. Choose VIEW → ADD EVENT THEME
8. Under Table select your point file: **Depth.dbf**
9. Select the X (e.g. Easting) and Y (e.g. Northing) fields if the defaults are not correct; Click OK

*A new point theme is added to the view. Display the points by checking on the box next to the theme name in the View window. Double click on the legend and change the symbol properties assigned to the Z-value (e.g. you can display each point as a different colour by assigning a colour palette to the Unique Value field of the Z-value Depth\_inch).*

10. Choose FILE → SAVE PROJECT AS... enter a name and save the project into the working directory

*You may need to navigate to your personal directory since the default directory may not be the directory in which you want to store your data.*

## ***C. Convert Lake Boundary to Points and Overlay With Depth Points***

This step has two parts: the first is to convert the shapefile boundary to a set of evenly spaced points, and the second is to overlay these new lakeshore points, which by default will have a depth of zero associated with them, to the original depth information.

## Part I: Convert the Polygon to Points

*Because the interpolation routine uses point data, this conversion and overlay of the lake boundary is necessary.*

1. Highlight the View window and add the **Lake.shp** theme; Choose VIEW → ADD THEME...
2. Display the lake polygon by checking on the box next to the theme name and make sure the **Lake.shp** theme is the active theme.
3. Choose THEME → CONVERT TO POINTS...
4. Enter “50” as the interval

*A smaller interval results in more points (and longer processing time), which of course also gives higher accuracy...*

5. In the next menu assign a directory and name for the grid that will be generated (e.g. **Lakepoints.shp**); Click OK
6. Enter “0” as the starting point for which the new points will be evenly created along the lake boundary; Click OK

*A temporary shapefile is added, called “Lake5.shp (every 50 m).” You can use this for further analysis, or you can delete it and add the permanent “Lakepoints.shp” theme. The instructions use the permanent theme name.*

## Part II: Overlay Lakepoints.shp with Depth.dbf

*To incorporate the lakeshore into the interpolation, you need to overlay the two sources of point data. Keeping the attributes of the original Depth.dbf automatically assigns a zero value to the Depth\_inch field for the Lakepoints.shp theme.*

7. Make **Lakespoint.shp** the active theme
8. Choose VIEW → GEOPROCESSING WIZARD...
9. Select Merge themes together and click Next
10. Choose BOTH **Lakespoint.shp** and **Depth.dbf** by holding the SHIFT key and clicking on each theme
11. Use fields from: **Depth.dbf** (to keep this theme’s properties, i.e. the Depth\_inch field)
12. Navigate to the appropriate directory and enter a name and for the new merged file (e.g. **Mergedpoints.shp**)
13. Click Finish and check the theme legend box to display **Mergedpoints.shp**

## D. Interpolate Continuous Surface of Depths

This step creates two new grid themes and has three parts: the first is to convert the shapefile to a grid, the second is to set the analysis properties so that the continuous surface will be generated within the extent of the polygon only, and the third is to perform the interpolation.

## Part I: Convert the Shapefile to a Grid

*Converting the Lake.shp to a GRID facilitates setting the area of analysis and is used for the interpolation properties.*

1. Make the **Lake.shp** theme active
2. Choose THEME → CONVERT TO GRID...
3. In the next menu assign a directory and name for the grid that will be generated (e.g. **Lakegrid**); Click OK
4. For the Output Grid Extent choose "Same as Lake.shp"

*This will keep the grid theme extent the same as the original polygon theme extent. You may need to scroll down to find the file.*

5. For the Output Grid Cell Size choose "1"  
(The units are in the same as from Step A.5. You can experiment with values other than "1" if desired.)
6. Use the default Number of Rows and Number of Columns values unless there is need to change those values; Click OK
7. For the Field for cell values "ID" should be highlighted; Click OK
8. Join feature attributes to grid? – Yes
9. Add grid as theme to the view? – Yes

## Part II: Set the Analysis Properties

*Setting the analysis properties ensures that the interpolation will be performed within the lake polygon boundary only (since lake depth should be zero outside of the lake).*

10. Choose ANALYSIS → PROPERTIES
11. For the Analysis Extent choose "Same as Lake.shp."
12. For the Analysis Cell Size choose "Lakegrid."
13. For the Analysis Mask choose the grid theme, "Lakegrid." (Note: the analysis mask is important for making contours terminate at the limits of the lake polygon.)
14. Use the default Cell Size, Number of Rows, and Number of Columns unless for some reason you desire other values; Click OK

## Part III: Interpolate the Surface

*There are different methods and parameters that can be used, and you will get very different results. The following is provided as a suggestion only; you may wish to experiment with alternate values.*

15. Make the **Mergedpoints.shp** theme active
16. Choose SURFACE → INTERPOLATE GRID
17. In the Interpolate Grid window choose the following parameters:
  - Method: Spline
  - Z Value Field: Depth\_inch (or, if different, the name of the field that contains the elevation values).
  - Weight: 0.1

- No of Points: 20
- Type: Regularized

## 18. Click OK

*ArcView will start processing the data. You may have to wait a while at this point. ArcView will then create the Surface theme. Check the box of the surface theme to display it.*

*If you enter a No of Points greater than 20, then ArcView may get “stuck.” Press CTRL-ALT-DELETE simultaneously to End Task. Save changes to the project when asked and re-open it.*

## **E. Convert to TIN and Calculate Volume**

The creation of a Triangulated Irregular Network (TIN) is needed in order to get 3-dimensional characteristics of your theme and make the volumetric measurement.

1. Make the **Lakedepths** theme active
2. Choose THEME → CONVERT GRID TO TIN...
3. In the next menu assign a directory and name for the grid that will be generated (e.g. **Depthtin**); Click OK
4. For the Z-value tolerance, enter “1”
5. Add TIN as theme to the View? – Yes
6. Make the **Depthtin** theme active
7. Choose SURFACE → AREA AND VOLUME STATISTICS...
8. For the base height, enter “0”
9. Calculate from which direction of base height: Above (if Z-values are positive) or Below (if Z-values are negative)

*A window pops up with three measures for area and volume. You can now record the volume statistic for future reference; the units should be the same as your Z-value Depth\_inch field, which you can later convert.*

### **EXTRA: Create Contour Lines**

1. Make the **Lakedepths** theme active
2. Choose SURFACE → CREATE CONTOURS
3. For the Contour Interval enter 10, or a value you prefer
4. For the Base Contour enter 0

*This base contour value can be the lowest Z value in the project area or take the default “0.”*

5. Click OK

*ArcView will then create the contour theme. Check the box of the theme to view the contours.*