

## Measuring Area/Length of Organisms with GIS

These instructions enable you to measure the length and area of microscopic organisms in ArcGIS from digital photographs. The four-step process involves:

- georeferencing the images
- digitizing the segments and areas of interest
- coding the attribute table, and then
- calculating the areas, perimeters, and lengths.

The digital images require a scale marked in the X and Y directions at the **time of photography**, such as a mesh grid of known cell size (e.g. 1 mm by 1 mm).

### ORIGINAL DATA

**A006.jpg** a digital photograph of the organisms in JPEG format with a planar grid of known dimensions visible in the image; read/write accessible

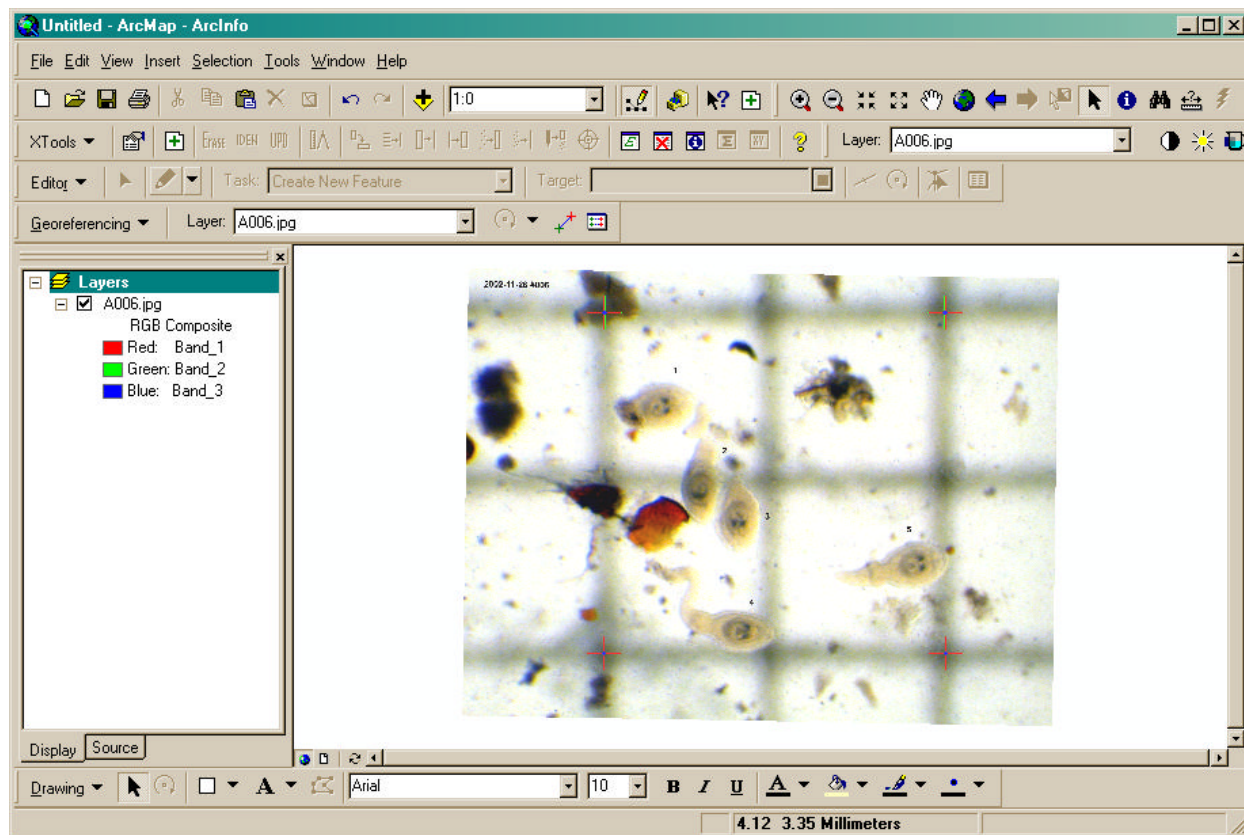
### CREATED DATA THEMES

**A006length.shp** a shapefile containing the digitized line segments with coded attributes and measured length values

**A006area.shp** a shapefile containing the digitized polygons with coded attributes and measured area and perimeter values

### *Start a new map document*

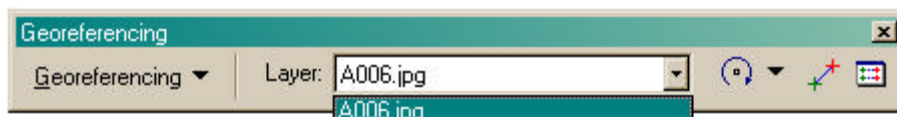
1. Choose START → PROGRAMS → ARCGIS → ARCMAP
2. Start using ArcMap with a new empty map
3. Choose VIEW → TOOLBARS and add the following toolbars:
  - Effects
  - Georeferencing
  - Editor
4. Click the ADD DATA button
5. Select the digital image (e.g. **A006.jpg**) and click ADD
6. Choose VIEW → DATA FRAME PROPERTIES
7. Click on the GENERAL tab
8. **Select Millimeters for the Map and Display Units**
9. Click OK
10. Adjust the Brightness/Contrast using the **Effects** toolbar





## Georeference the image

For more detailed information, refer to the **ArcGIS Desktop Help** and search for the following topics: “About georeferencing” and “Georeferencing a raster.”


1. From the **Georeferencing** toolbar, click the Layer dropdown arrow and click the raster layer you want to georeference; e.g. A006.jpg



2. Click **GEOREFERENCING** → **FIT TO DISPLAY**
3. Click on the **CONTROL POINTS** button 
4. Click the mouse pointer on one of the known corner locations of the image to add the link – a green cross appears to mark the source location
5. Click again in the same spot – a red cross appears to indicate the map location (doesn't have to be exact as you will type in the proper coordinates later)
6. Repeat the preceding two steps for the other three corners
7. Click the **VIEW LINK TABLE** button to evaluate the transformation 
8. Click a map coordinate and type in the known value; e.g. X=1, Y=1

Link	X Source	Y Source	X Map	Y Map	Residual
1	485.278976	-1311.931267	1.000000	1.000000	0.00350
2	472.858491	-140.265499	1.000000	3.000000	0.00350
3	1652.804582	-119.564690	3.000000	3.000000	0.00350
4	1673.505391	-1291.230458	3.000000	1	0.00350

Auto Adjust    Transformation: &1st Order Polynomial (Affine)    Total RMS Error: 0.00350  
 Load...    Save...    OK

9. Examine the residual error for each link and the Total RMS error
10. If satisfied, click SAVE to save the link table as a text file  
*For ease of recognition, name the link file to match the original raster image; e.g. **A006.txt**.*
11. Click OK
12. Click on the FULL EXTENT button 


Name	Size	Type
a006.aux	12 KB	AUX File
a006.jgw	1 KB	JGW File
A006	2,396 KB	JPEG Image
A006	1 KB	Text Document

*This creates two new files with the same name as the original .jpg raster but with .aux and .jgw file extensions. Make sure to save and copy all associated files so that the next time you add the image to ArcMap, the georeferencing information is present.*

13. Choose GEOREFERENCING → RECTIFY if you decide to permanently transform the image by saving to a TIFF or GRID file format


## Digitize the shapefiles

### Create a new shapefile:

1. Click on the ENHANCED CREATE SHAPEFILE button 
2. Select POLYGON as the type of geometry
3. BROWSE to your working directory and type a new name for the shapefile; e.g. **A006area.shp**
4. Click on the FIELDS button
5. Click ADD FIELD, type a name, select parameters and click OK
  - **CODE, Text, 4**
  - **WORM, Short Integer, 3**
  - **SOURCENAME, Text, 20**
  - **AREA, Float, 10, 8**
  - **PERIMETER, Float, 10, 8 (or LENGTH)**

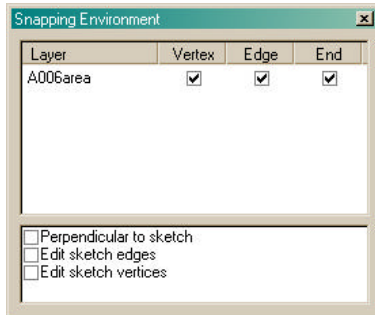
*Repeat for any other fields you desire, or alternatively click on the IMPORT FIELDS button to copy attribute fields from another shapefile*


6. Click OK twice

7. The new shapefile appears in the table of contents. Click on the symbol to select a different style and color.
8. ZOOM to the organism if necessary 


### Trace the body (digitize polygons):

9. In the **Editor** toolbar, choose EDITOR → START EDITING
10. Select the target layer to edit; e.g. **A006area.shp**
11. Select “Create new feature” as the Task

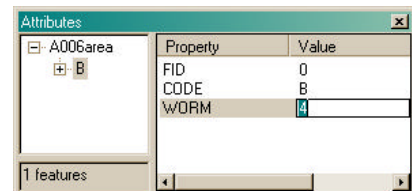



12. Choose EDITOR → SNAPPING...
13. Check VERTEX, EDGE, and END for the Snapping Environment in the **A006area** layer then close the window
14. Click on the sketch tool 
15. Click a starting node
16. Move the mouse pointer to where you want to place a vertex and click the mouse to set the vertex
17. Move the mouse pointer to where you want to place the next vertex and click

18. Continue moving and clicking until you have traced the entire perimeter
19. Double click to finish the polygon  
*Use shorter distances between vertices to yield a smoother outline for your polygon. Also, zoom in closer to help you discern the detail better.*

20. While the finished feature is still selected (highlighted), click on the  ATTRIBUTE button

21. Click beside the CODE field and type in a value
22. Click beside the WORM field and type in a value
23. Zoom to the FULL EXTENT



24. ZOOM to the next organism, digitize,  and code the attributes
25. Repeat until all organisms in the image are digitized
26. Choose EDITOR → SAVE EDITS often
27. When finished, choose EDITOR → STOP EDITING
28. Click YES to save your edits

#### Editing a sketch:

- Select Modify Feature from the Current Task dropdown arrow
- Select the Edit tool and click the feature that you want to modify

#### ADDING/DELETING:

- Right-click over the vertex you want modified
- Click Insert or Delete Vertex

#### RESHAPING:

- Position the pointer over the vertex you want to move until the pointer changes
- Click and drag the vertex to the desired location

When finished, right-click over any part of the sketch and click Finish Sketch

**Trace the segments (digitize lines):**

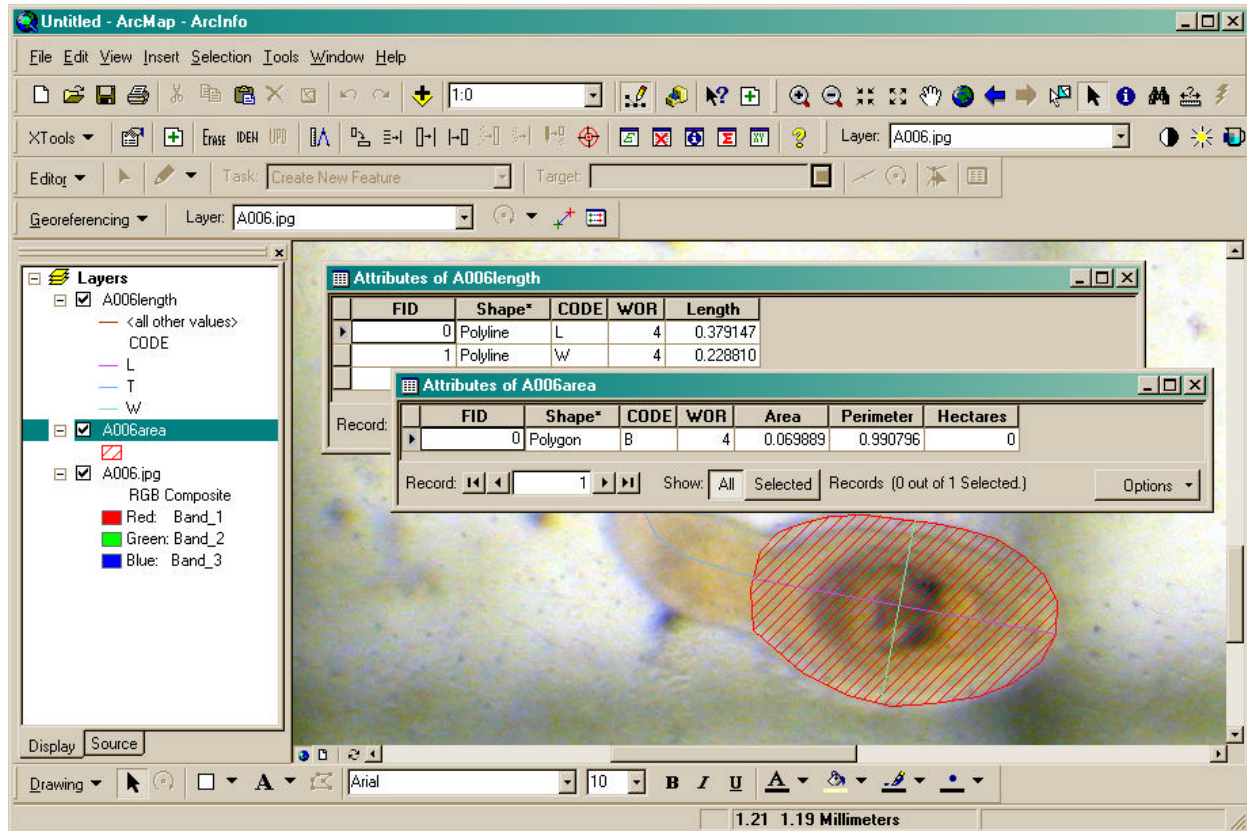
29. Use the ENHANCED SHAPEFILE CREATE tool to create a POLYLINE shapefile; e.g. **A006length.shp**
30. Choose to IMPORT FIELDS to copy the same fields you defined for the polygon shapefile
31. Modify the line symbol color for better visibility
32. Choose EDITOR → START EDITING
33. Select the target layer to edit; e.g. **A006length.shp**
34. Select “Create new feature” as the Task
35. Choose EDITOR → SNAPPING...
36. Check VERTEX, EDGE, and END for the Snapping Environment in the **A006area** and **A006length** layers then close the window  
*Setting the snapping in this way causes vertices and nodes of your line segments to coincide with the edges of your polygons.*
37. ZOOM to the organism
38. Click on the sketch tool
39. Click a starting node
40. Continue moving and clicking until you have traced the entire segment
41. Double click to finish the line
42. Enter the attribute values as above
43. Repeat for each organism in the image
44. Choose EDITOR → STOP EDITING

**Calculate the source name field:**

45. Right click on each layer name and OPEN ATTRIBUTE TABLE
46. Right click on the **SOURCENAME** heading
47. Type in “**A006.jpg**” (or corresponding image name) and click OK

**Calculate the length/perimeter/area measures**

1. Open the attribute table (if not still open)
2. Right click on the **AREA** field heading and choose CALCULATE VALUES
3. Click the LOAD button
4. Navigate to the **C:\arcgis\easycalculate** directory
5. Click on **polygon\_Return\_Area** and click OPEN
6. Click OK
7. Close the table calculator
8. Right click the **PERIMETER (or LENGTH)** heading and CALCULATE VALUES
9. Select **shape\_Return\_Length**, click OPEN, and click OK
10. Click the OPTIONS button
11. Click EXPORT
12. Save the table as a \*.dbf for import into Excel or a statistical package



## Hints and tips

### Make a batch of shapefiles:

- Create the empty shapefiles complete with all the desired attribute fields for the area and length digitizing files (e.g. A006area.shp and A006length.shp)
- In ArcCatalog, copy several sets of the files and rename to match the digital images that they will be digitized on
- Then when in ArcMap, you may skip the Enhanced Shapefile Create step and simply add the appropriate shapefiles to the georeferenced image that you want to digitize

### Organize your data:

- Once all your digitizing and calculating is completed, add all shapefiles to a map document
- Choose TOOLS → GEOPROCESSING WIZARD to MERGE the polygon and line files into two separate mega-files
- Export the tables for the line and polygon features