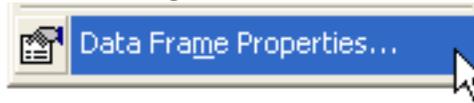


Mike's quick-and-dirty guide to georeferencing scanned images (maps) in ArcGIS 10

- A) Prepare map for georeferencing
- Scan your map at fairly high resolution (~600dpi) and save as a TIF or PNG file.
 - Crop the resulting image file to remove any "extra" pixels. This may be done before the final scan or in an image editing application such as the Gimp or Photoshop after scanning.
- B) Start ArcMap and add layers you will use to register your image. Good choices might include Township and Range lines, a survey sections layer, or recent-vintage orthophotography.
- C) Ensure that your data frame (default name is Layers) has a coordinate system defined.
- You may verify this by double-clicking on the data frame's name or by selecting View > Data Frame Properties...



- If you wish to have your image saved in a coordinate system different from your reference layers (e.g., your reference layers are in Michigan Georef and you would like your scanned image to be in UTM) you may choose a different coordinate system for your data frame. FYI: using a coordinate system in another datum (e.g., NAD 83 vs. NAD 27) is not recommended.
- D) Add your scanned image to your map. You will be asked if you want to build pyramids. Answer Yes, as these speed layer drawing times. You may see a "this layer has no coordinate system defined" error message - Click OK to dismiss.
- E) Make the Georeferencing toolbar visible: Customize > Toolbars and select Georeferencing, or right-click on an unused toolbar area and choose Georeferencing from the contextual menu.

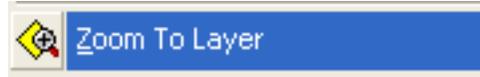


- F) Your scanned image should be selected in the Georeferencing toolbar under Layer: If it is not, be sure to select it from the drop-down menu before proceeding.



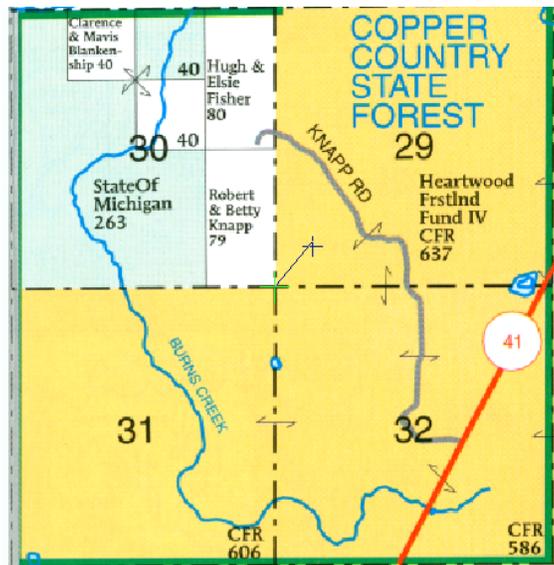
- G) The tools labeled A, B and C on the toolbar above allow you to rotate your scanned image (A), add link points to link your scanned image to your reference data (B), and view a table of any link points you have added, as well as check their quality (C).

- H) Right-click on your scanned image in the Table of Contents and choose Zoom To Layer. As your scanned image has no coordinate system defined, it will be somewhere near the Equator and the Prime Meridian in coordinate space - millions of meters away from your reference layer.

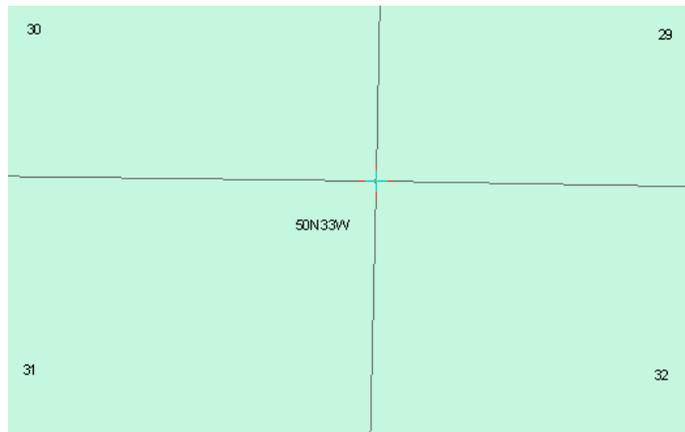


- i. Zoom in further on your scan, if necessary, and choose a feature that you can easily locate on your reference layer. In this example, I am georeferencing a plat map, so I will use the section grid to register the image.

- ii. Click on the Add Control Point tool on the georeferencing toolbar,  and click once on the feature you are using as a control point (section corner common to 30, 29, 31, 32 in the example).



- iii. Click on the Go back to previous extent tool  several times until you can see your reference layer. Zoom in to the point on the reference layer that you selected on your scan (the section corner common to 30, 29, 31, 32), choose the Control Point tool on the georeferencing toolbar again, and click to link the two control points.



- I) Repeat the steps under H) until you have added at least four control points to your image and reference layer. You will need to use "zoom to layer" and "Go back to previous extent", as well as the zoom in tool, to accurately add these points. You may need to turn on and off your reference layers, too.
- i. Try and select points that are well distributed across your image - if they are grouped together, the georeferencing will work poorly.
 - ii. You should always first add the control point to the scanned image, then select the corresponding point from your reference layer.
- J) After adding a minimum of four points, click the icon on the Georeferencing toolbar to open your Link points table.

Link	X Source	Y Source	X Map	Y Map	Residual
1	1.129039	1.196078	387580.255861	5172157.716580	5.07688
2	5.854629	5.967495	394121.074679	5178465.100166	3.33898
3	5.867047	1.208658	393999.861055	5172037.158394	1.99055
4	1.132846	2.380649	387611.690414	5173764.408480	5.08129
5	5.866703	4.785440	394099.603963	5176861.600584	4.71164

Auto Adjust Transformation: 1st Order Polynomial (AI) Total RMS Error: 4.21675

- i. X and Y source coordinates are given in scanned image units (inches), and X and Y map values are in projected units (UTM coordinates in the example). The Residual val-

ue is most important: it gives the error, in meters, each control point is contributing to the georeferencing (the amount that is "unexplained" by the georeferencing, or the difference between the "expected" and "actual" control point locations). What causes this error? There is error in all spatial data. Allowable error, according to National Map Accuracy Standards (NMAS), on 1:24,000 topo maps is +/- 40 feet, or about 12 meters. Other sources could include digitizing error. Plat books are not as accurate as topo maps.

ii. The total error shown above is ~4.2 meters - less than allowable NMAS - and is more than acceptable. Values below 10 are OK, and below 5 are great. If you have any values that are high, you may select the row and click the X at the upper right to remove the control point. Note that the other RMS values will change, and if you had only 4 control points, you will need to add another before final georeferencing.

iii. Click OK to continue if your RMS error is reasonable. If you need to add or adjust link points, go back to step H.

- K) From the Georeferencing menu, choose Update Georeferencing. This will save the transformation to a text file in the same directory as the image. This text file tells ArcMap where to display the image. If you later move the image to a new location, use ArcCatalog, or be sure to move all the "parts" of the image file (.tif, .aux, .rrd, tfwx) to the new location. (If you use .png format, the file extensions will be different).



If you have multiple images to georeference, be sure to get through step K) before moving to a second image. You will need to choose your second scanned image (photo or map) from the Layer: menu before adding control points. You should follow steps F) through K) for each subsequent image you need to georeference, ensuring that you “update georeferencing” before starting with another scan.