

## Tutorial 5 – Heads-up Digitizing in ArcMap

*Note: Before beginning the tutorial, copy the Lab5 archive to your server folder and unpack it.*

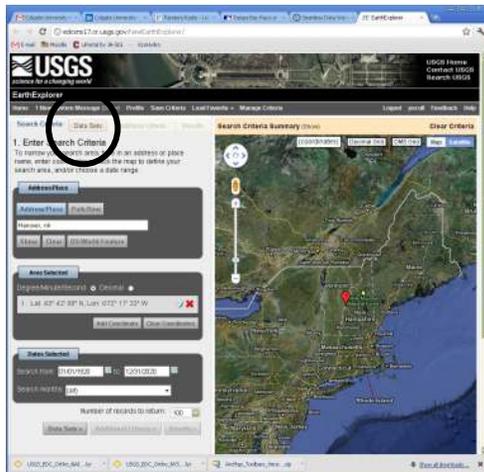
### The objectives of this tutorial include:

1. Learning how to georegister/georeference an image
2. Creating an empty geodatabase
3. Digitizing features from an image into the geodatabase
4. Editing digitized features.

### Lab Preface: Browsing on-line data

Open Mozilla and navigate to: <http://edcns17.cr.usgs.gov/NewEarthExplorer/>

Enter your hometown in the ‘Address/Place’ window and hit enter. Assuming the site can find your address it will enter the DMS of the center of your town in the ‘Area Selected’ box below (see example below)



Click on the ‘Data sets’ Tab (circled above).

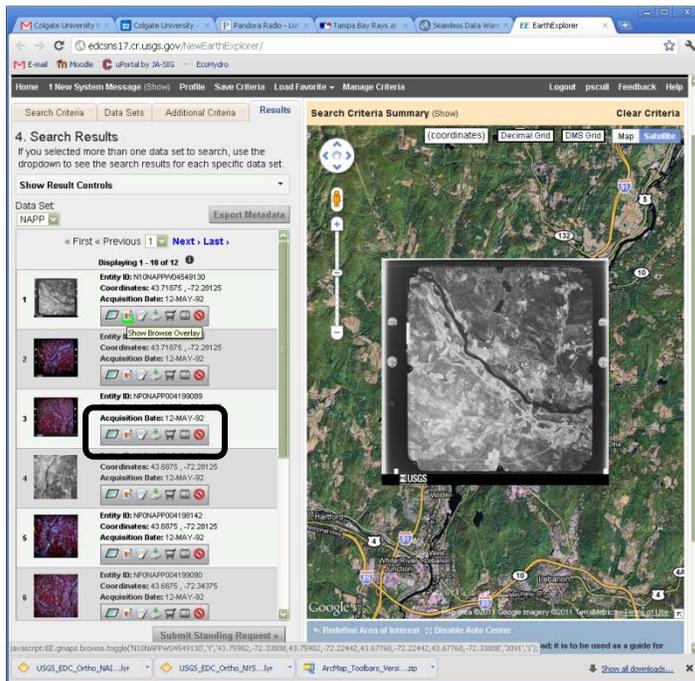
Expand the ‘Aerial Photography’ suite of options and check the ‘NAPP’ box (see below). What does NAPP stand for? Click the circled ‘i’ next to the box. A new window should pop up to explain.



Click the ‘results’ button at the bottom (circled above).

A list of available images should appear on the search window (as shown below). Click on the 'show browse overlay' button on one of the images in the list. The viewer window should zoom to the approximate extent of the data (also shown below). Is the image you are viewing georeferenced? How would you know? Explore other available datasets. What is the oldest imagery you can find for your hometown, or specifically for your neighborhood?

Mouse over the other buttons in the search window (circled below). Which one would you need to use to actually download the data?



The Earth explore is one of the ways the USGS distributes data. You may find it useful to come back here to search for data in the future (e.g. your class project!). A description of other on-line data viewers can be found here:

[http://eros.usgs.gov/#/Find\\_Data/Data\\_Discovery](http://eros.usgs.gov/#/Find_Data/Data_Discovery)

## Heads-up Digitizing in ArcMap

### Introduction

The remainder of this lab will introduce you to the creation of new GIS data using a process called heads-up digitizing. In brief, this process involves adding a georeferenced image in ArcMap, creating an empty geodatabase in ArcCatalog, and using ArcMap's drawing tools and the mouse to trace features from the image into the geodatabase. We call this heads-up digitizing because you do this work while looking at the image on the computer screen. The new digitized features will carry the geographic reference system of the image.

For this tutorial, you will use a 1936 black and white air photo of the Bewkes Center, which a Colgate-owned piece of property that has undergone significant land cover change since the 1930s. A quick review of the 1936 image, which can be seen below, shows large areas of open field, forest, and a lake in the middle of the property. A copy of this image, which is in TIFF format, is contained in the Lab5 archive.



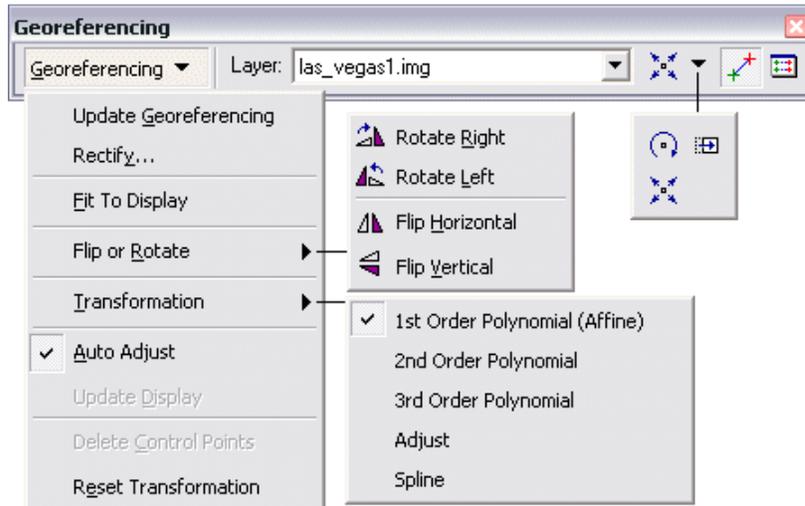
1936 Bewkes Photo

Unfortunately, this 1936 Bewkes image does not have any spatial reference information (geographic and projected coordinate systems) – it is simply a digital photo. The process of adding geographic reference information to an unregistered image is called georegistration (or georeferencing). This process requires that you tell ArcMap the coordinates of at least three points on the unregistered photo. We will be using two 2008 aerial photos of the Bewkes Center to perform the georegistration. These photos are named `c_10741024_24_19200_4bd_2008` and `c_10741020_24_19200_4bd_2008` and are contained in the Lab5 archive. Both are registered in the NY State Plane (central zone) coordinate system (NAD83) and the units are feet. (Make sure you add the airphotos before you add the Bewkes image. Question: Why would you do this in this order?)

If you have not done so yet, expand the ArcMap window to the full extent of your monitor so that you can see necessary details during georeferencing.

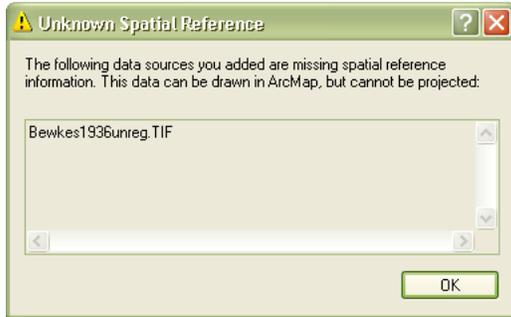
## Georeferencing

Make sure the Georeferencing Toolbar is turned on. To do this, open the Customize menu, select Toolbars, and find Georeferencing. The figure capture below provides an overview of the Georeferencing toolbar.



Button	Name	Function
	Rotate	Rotates the source layer.
	Shift	Shifts the source layer.
	Scale	Rescales the source layer.
	Add Control Points	Allows you to select control points from a layer and add them to the map.
	View Link Table	Shows links and errors in tabular form.

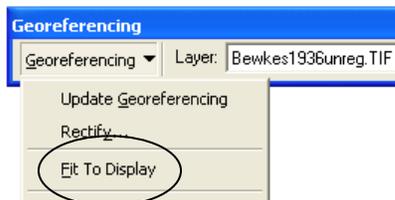
Add the two georeferenced 2008 images that begin with 'c\_107' to the map view; the other two are for campus. Make sure you zoom to the full extent of both layers and then add the unregistered 1936 photo (Bewkes1936unreg.TIF) to the map view (**Question:** why do you need to add the 2008 images first?). You may not see the unregistered map because it has no coordinate information, and ArcMap does not know how to line-up with the registered image (you will get an error like the one below telling you the layer has no projection).



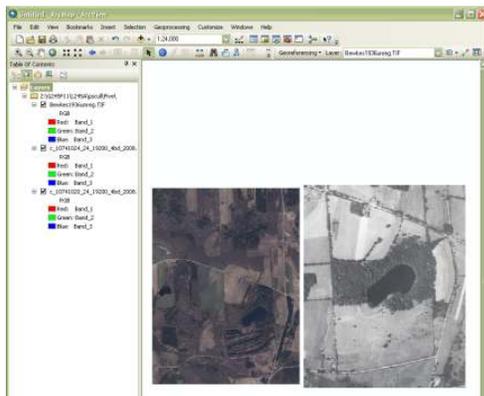
Make sure the Georeferencing toolbar layer is set on the unregistered image (see below). Adjust the pull down if it is not. This layer is called the source layer.



Under the Georeferencing menu, select Fit to display (see below). The unregistered image will appear. In fact, it might even hide the registered image. You will need to see both image, so select the Shift tool (Fig. 4) to drag unregistered image to the side. You can move the source layer (unregistered image) around because it is not yet spatially referenced.



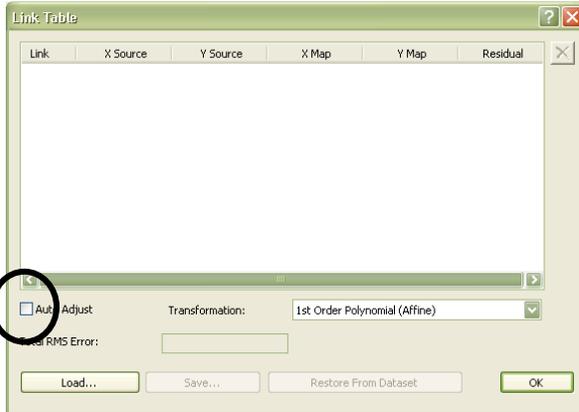
Try to arrange the layers so that they look like the example below. If you are having trouble ask your lab instructor for help.



Open the View Link Table (circled below).



Uncheck the Auto Adjust box (circled below). Move it out of the way, but keep it open.



When you have arranged the images so that you can see the registration points on both images, select the Control Point tool (circled below)



Use the control point tool to draw connections between the points on the unregistered image and the same points on the registered image. Do this for at least four points (see below). Road intersections usually work well. Blue lines will be drawn showing the connections.

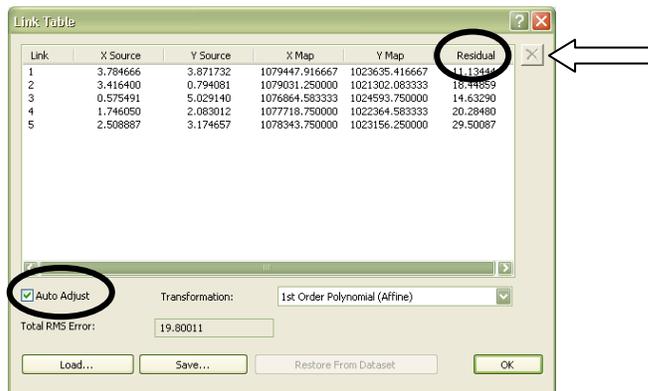


Please note that, if you did not uncheck Auto Adjust, the unregistered image will begin “warping” as soon as you create the first control point. This is not a problem except that the warping image may block your view of the 2008 images. In this case, you can use the control point tool to first click on the 1936 image, turn it off in the table of contents, and then click on the appropriate location in the 2008 image.

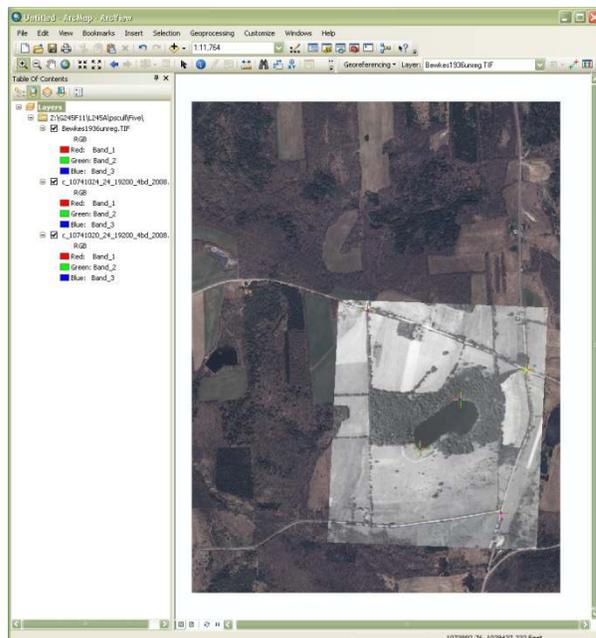
**Important:** When you are building links between the image and the points, you must be sure that you click first on the unregistered 1936 image and second on the registered 2008 image. You can also zoom in on the image when constructing the links. This might make it easier and georeferencing becomes more precise.

Observe the View Link Table. You will see a table similar to the one below that shows the coordinates from each image. (Note, this will only become populated after Auto Adjust is checked.)

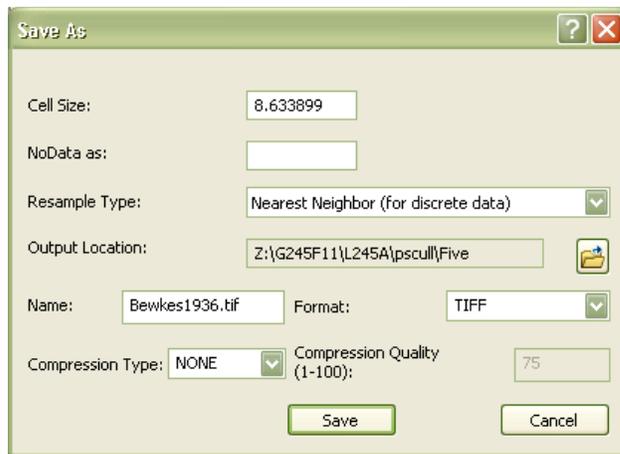
- What do the “residuals” and “total RMS error” indicate? What is your RMS value?



If you make a link you don't like, click on the link, and delete using the X on the side of the Link Table (see arrow above). When you are done creating links, click Auto Adjust, and you will see the 1936 image warped onto the 2008 image – (making sure the unregistered image lays on top of registered image).



Select the Rectify option under the Georeferencing dropdown menu. This creates an entirely new image with the new coordinate system. **However, when using “rectify” make sure that you set the output file format to TIFF, give an appropriate file name, and pay attention to where you are saving the image and that the name ends with a \*.tif suffix (i.e. bewkes1936reg.tif).** You can take the defaults for the other options.



Make sure you have selected a folder into which you want to save. If you can't, try clicking to another folder and then click back. Make sure your folder of choice fills in the space for “Name.”

Then you can change the name and the format.

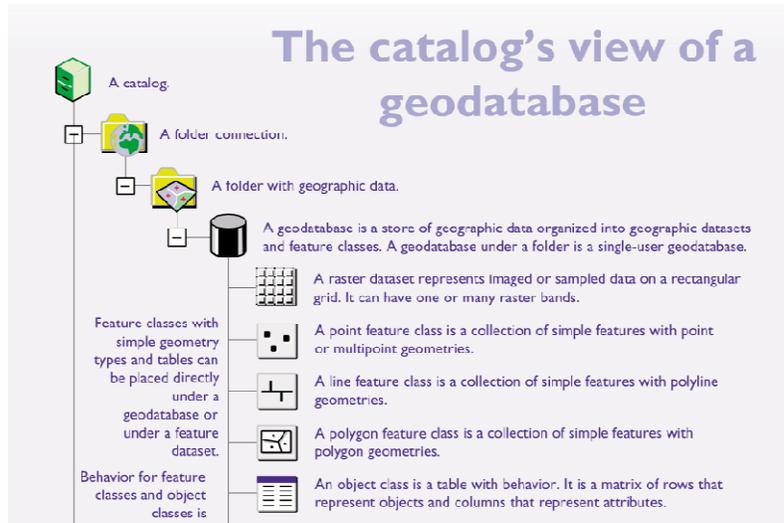
Unlike some ArcMap tools you will need to add the new image to see it. Open a new map view and add your new registered Bewkes image. This image becomes the base image for digitizing the 1936 Landcover.

You can remove the unregistered image, close the ‘Link Table’ and remove the georeferencing toolbar. Assuming things went well you won't need them until you get to the exercise.

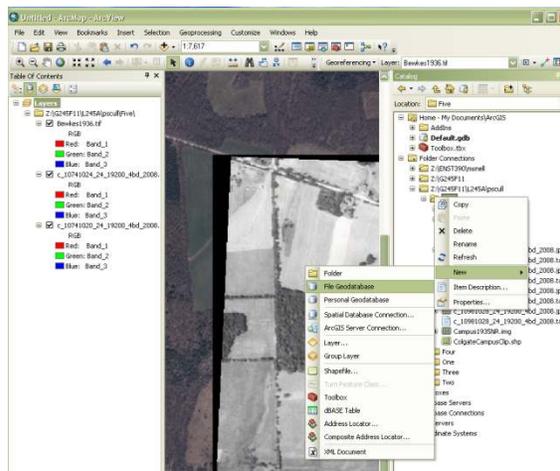
## Creating a New Geodatabase

In order to digitize from the registered image, you will need to create a vector-format data storage (recall coverage, shapefile and geodatabase). Here you will create a new geodatabase, and we will make a map showing land use for the Bewkes Center. We will keep it simple and go with four land use types: forest, non-forest, water, and developed.

Just to get the terminology straight, you are going to create a geodatabase that contains a polygon feature class, which shows polygons representing different land use types. You will not do it in this tutorial, but you could add more feature classes to this geodatabase, such as a point feature class showing the locations of water fountains and a line feature class showing roads.



Open ArcCatalog (do you remember how to add it to your view? If not ask the person next to you), navigate to your workspace, right click on your lab five folder and select new → File Geodatabase (see below). Change its name to something more appropriate (the default is ‘New File Geodatabase’).

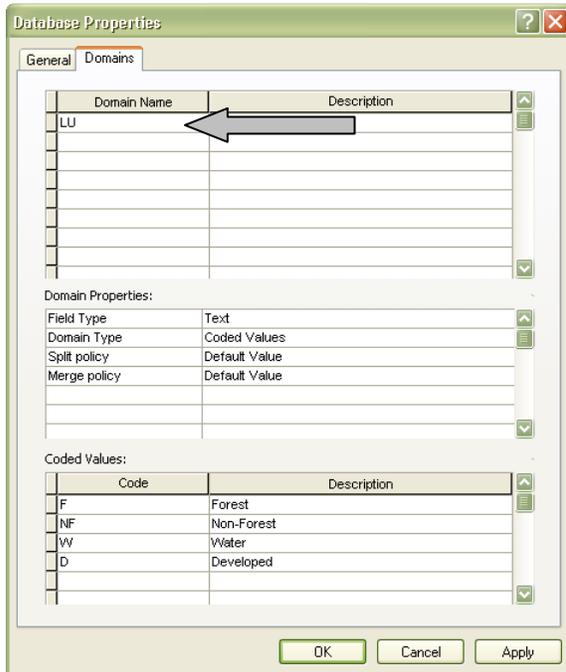


### Defining an attribute domain

One of the advantages of storing your data in a geodatabase is that you can define rules about how the data can be edited (e.g., what land use types are allowed, how many types, etc. when digitizing an image). These rules are defined in an attribute.

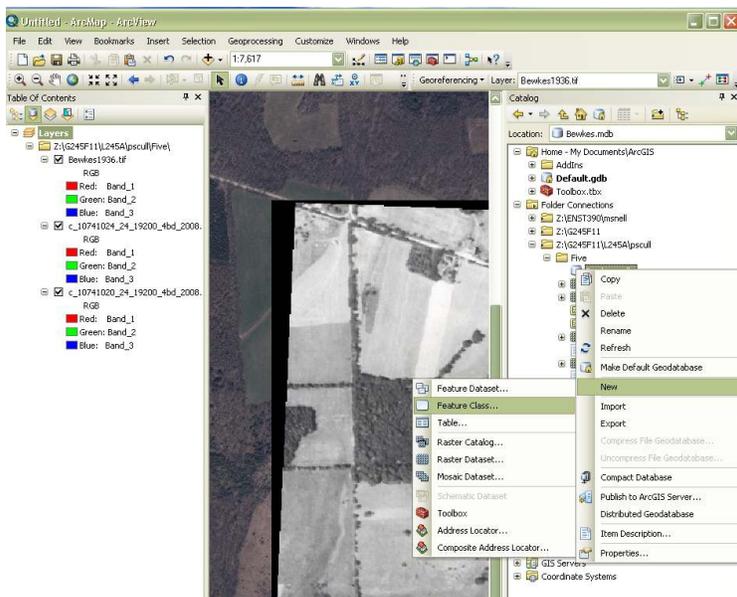
Right click on the new geodatabase, select ‘properties’ and switch to the ‘domains’ tab. Once there add a coded value text domain item called ‘LU’ directly into the empty box and code in our four classes (your window should look like the one below). You will need to click the “text” field to change it to “Domain” in the top window. Then, you will also need to click next to Domain in the lower window and select ‘LU’.

You should see the projection information from the layer you are importing at the top. Once you see it, click OK.

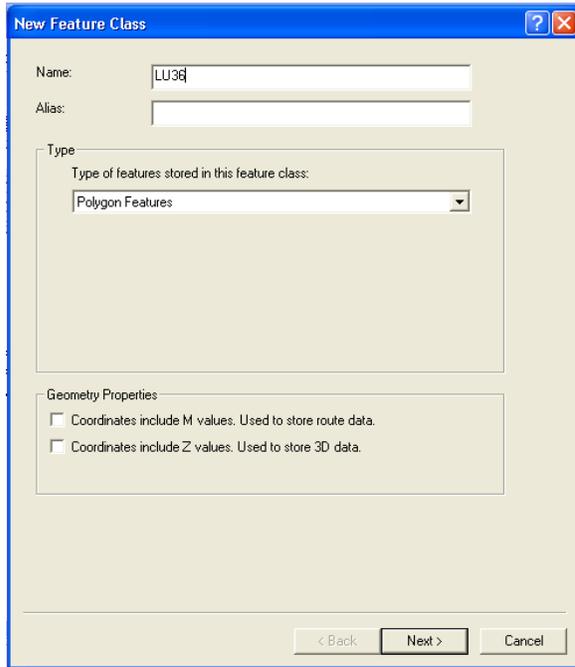


Adding a feature class to the geodatabase

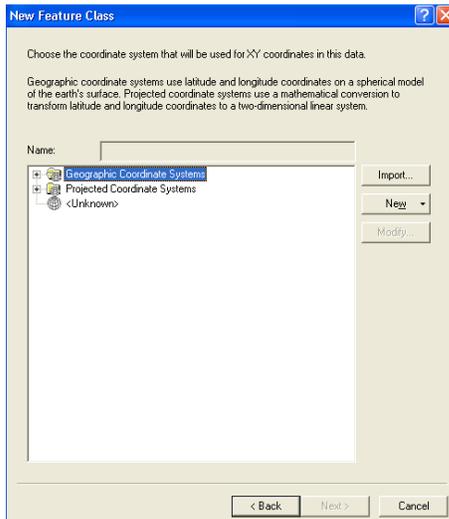
In the ArcCatalog window, right click on the new geodatabase (Bewkes in this case), select 'new' and then 'feature class' (see below)



A new feature class wizard will pop up. Name the feature class LU36 and set type to polygon features. Leave the alias blank (see below).

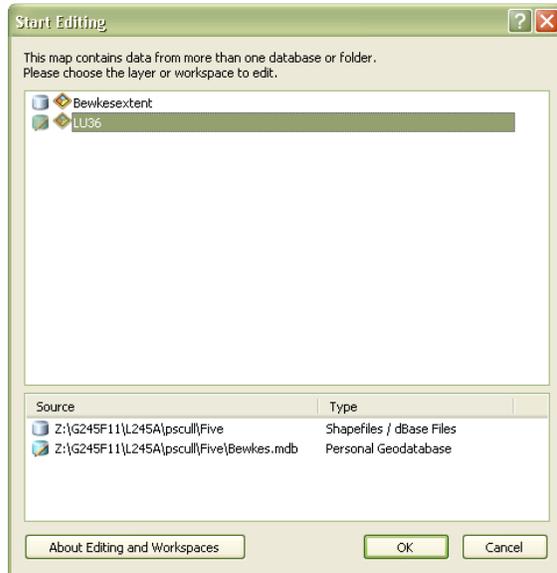


The next screen will ask you to select the coordinate system. We will take the easy approach and import the coordinate system from the image we just rectified. To do this click the import button and navigate to image you created above and click Add, followed by Next. Accept the default when asked about the XY tolerance.





Left click on the editor dropdown and select ‘Start Editing’. A window similar to the one below will pop up. Make sure you highlight the layer you want to edit (LU36 in this case) and then select OK.



Add the snapping toolbar, which is an option within the editor toolbar (left click ‘Editor’ then select ‘snapping’ and then ‘snapping toolbar’). The following toolbar will appear:

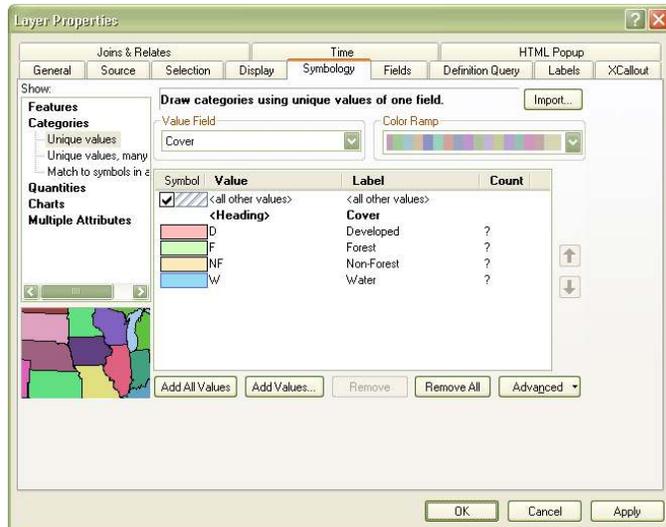


You can hover over each of the buttons to determine their meaning, but in general using snapping enables you to make sure adjacent polygons that share a common boundary also share the same exact nodes. It also enables you to use the ‘auto-complete’ tool. You’ll find it VERY useful and we would encourage you to explore its use. The snapping pulldown menu on the toolbar enables you to go in to the snapping option and change the snapping tolerance, or the distance that defines how close you need to be before a snap will actually occur.

**Note:** Your lab instructor will demonstrate this tool at the beginning of class.

**Question:** what is the difference between snapping to vertices and snapping to edge?

Before you start digitizing you should also consider symbolizing your feature class. I would recommend doing something like what I’ve done below, but make sure you make the layer 50% transparent so that you can see through your polygons. Note that I have symbolized ‘all other polygons’ as an obnoxious diagonal stripe. This is because I want to see the polygons that are not labeled appropriately.



**\*\*NOTE\*\*** There are many tools available to you to actually do your onscreen digitizing. Below we have highlighted a subset of them to get you started. Again, please consider playing around with the various tools during the tutorial before moving on to the exercise, and be sure to ask your lab instructor for help if you do not understand what you are doing. **\*\***

The general routine involved drawing polygons are around each of the individual landcover types and labeling them appropriately. Do to so you'll need to know how to use a variety of editing tools and will be learning how to turn your cursor into a variety of different "tools".

### Creating new features (independent of others)

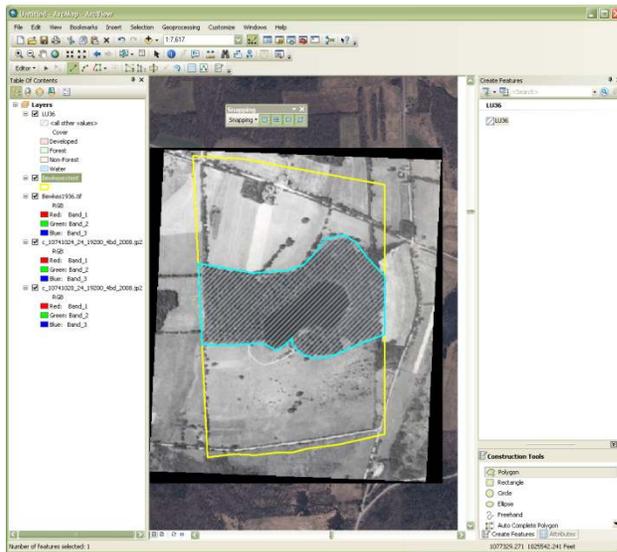


The 'create features' panel on the right side of the main ArcMap window should appear once you start editing. The 'Construction Tools' at the bottom of this window (shown below) are used to make new objects (as opposed to modifying existing ones).



You can see that you have the option of creating a new feature (a polygon in this case since we have defined our feature as such) one of four different ways. The tool at the bottom (Auto Complete Polygon) can only be used to create a new feature using a portion of the boundary of an existing one.

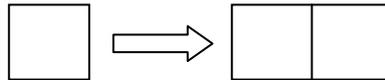
In the example below I have digitized the forest (including the pond) using the 'polygon' feature. You begin and end polygons by clicking in open within the map view (double click to end).



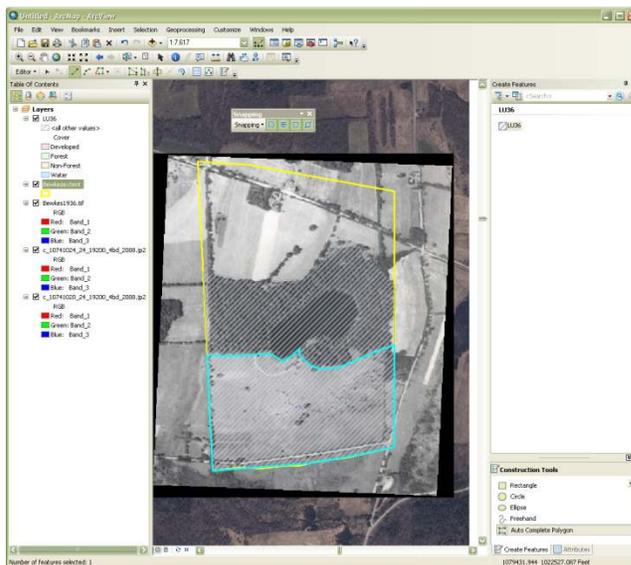
### Creating new features (dependent on others)

There are two ways of creating new features from existing features: autocomplete polygon and cut-polygon

#### 1. 'Autocomplete polygon'



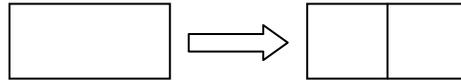
This tool literally appends a polygon to an existing one. In the example below I have digitized a non-forest polygon using the southern boundary of my forest polygon. I did this by initiating autocomplete polygon on the lower-right corner of the existing boundary. I then traced the boundary file (attempting to select each individual vertex) and then ended my polygon (double-click) on the lower left corner of the forest polygon.



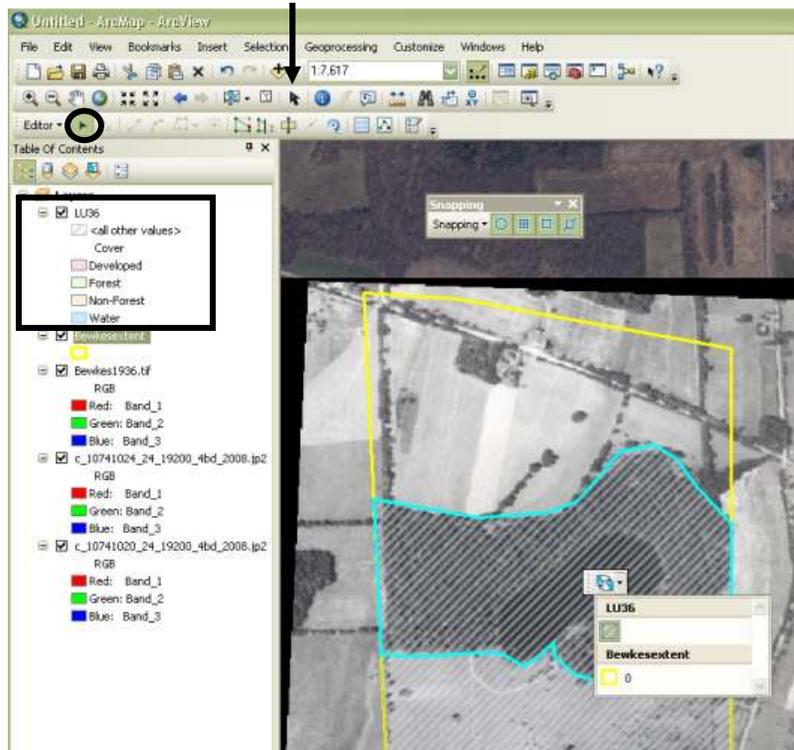
The advantage of this approach is that you do not have to duplicate the southern boundary of the polygon existing polygon. And there will not be any slivers in between them.

*Question: why don't you want any sliver polygons? Ask your lab instructor if you don't understand the answer.*

## 2. Cut-polygon



The other way to create a new feature using an existing feature is to split a polygon in two. This is exactly what is needed to pull out the lake from my forest polygon. First you'll need to select the polygon you want to split (or 'cut' to use ArcMap terminology). You do this by making sure you are in the editing select mode (click the cursor shown by the circle below). This is a different shaped arrow than the normal cursor (to turn yourself into a normal cursor select the standard cursor button; see arrow below).



You can tell I've selected my forest polygon because it is highlighted (blue on screen). Notice too that in my example when I tried to select it a little button appeared. This button is used in instances where there are a variety of things on top of one another. If you are having trouble selecting something because it is 'underneath' then you can toggle your selection using this button. In this case, I can toggle my selection between the boundary polygon (in the Bewkes Extent layer) and the forest polygon in LU36. If you

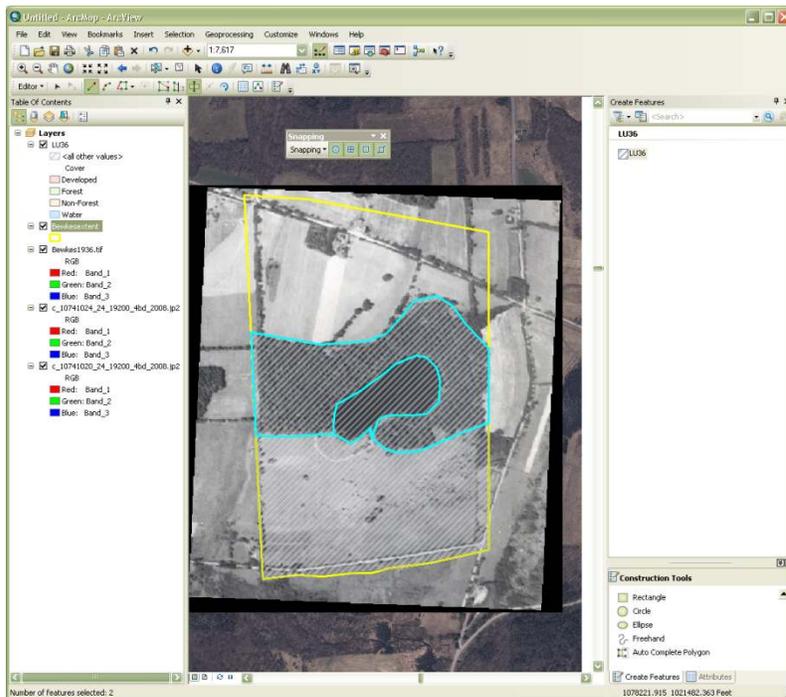
make sure that LU36 is always on top of BewkesExtent, as shown in the rectangular box above you shouldn't have the need for this toggle switch.

Note: if only one layer is showing the toggle button will not appear (because you wont need it).

Once the polygon you wish to split is selected you need to turn your cursor into a “knife” to perform the cut. This is done by selecting the button circled below from the main editor toolbar.



Once you are in cut mode you must first click outside the selected polygon, then move inside to define the cut, and then you must finish by double clicking outside the selected polygon. In the example below I have cut out the pond.



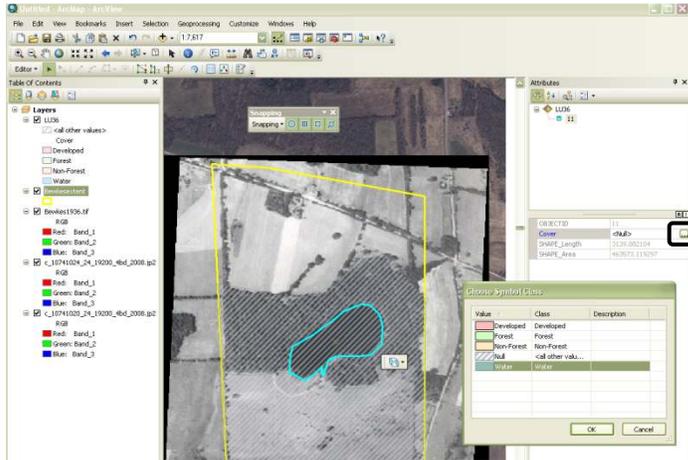
## Labeling features

You should identify a label for each feature as you go along. To do this you'll need to open up the 'Attributes' window by selecting the 'attributes' button (circled below).



This will change the look of the panel on your right. Each selected polygon will appear at the top and you can view that polygons attributes below. You can also make changes

to the 'cover' type using the domain you defined earlier using this feature. Before you change a 'cover' value you'll see that it is listed as '<Null>'. Left click once on the '<Null>' and then left click on the small button that appears (circled below).



This will open a window like the one show in the example above. Here you define the cover type of the polygon. In my example I am defining the pond polygon as 'water'. Once you define it they symbology should change it from vertical striped to blue.

If you have not symbolized the layer you this window will not appear.

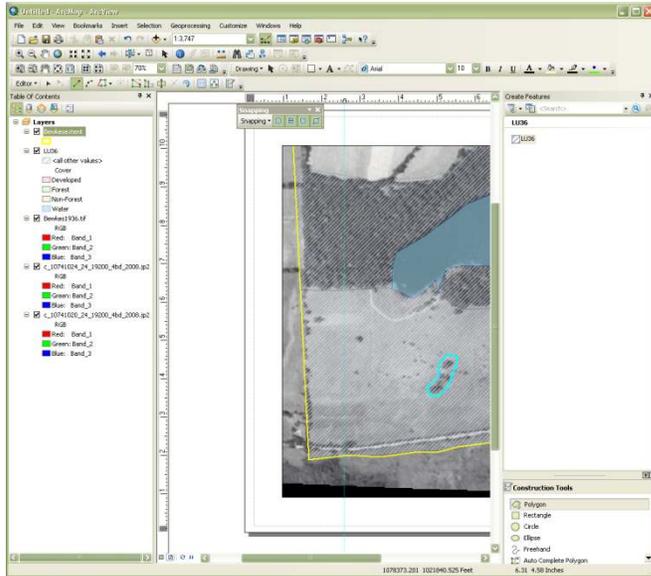


You may find yourself in a situation where you need to draw a polygon within a polygon in the same layer (do you follow?). Such a task does involve adding a new feature, but that feature is neither purely independent nor dependent on existing polygons; thus, it doesn't fall into our two categories of creating new features.

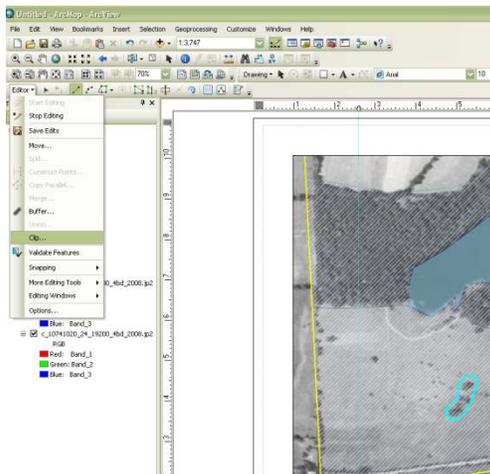
If you simply added one it would be drawn on top of the existing polygon and you can't "cut" the existing polygon because that tool needs to be initiated and terminated outside of a given polygon (just like it's hard to use scissors to cut a hole in a the center of a piece of paper).

The way to deal with this is to initially draw a polygon on top of your existing one. Below I have done just that to distinguish a group of trees in the middle of a field that I want to call "forest".

GEOG 245: Geographic Information Systems  
Lab 05 – FA11



Then, select 'Clip' from the main editor pulldown menu (circled below).

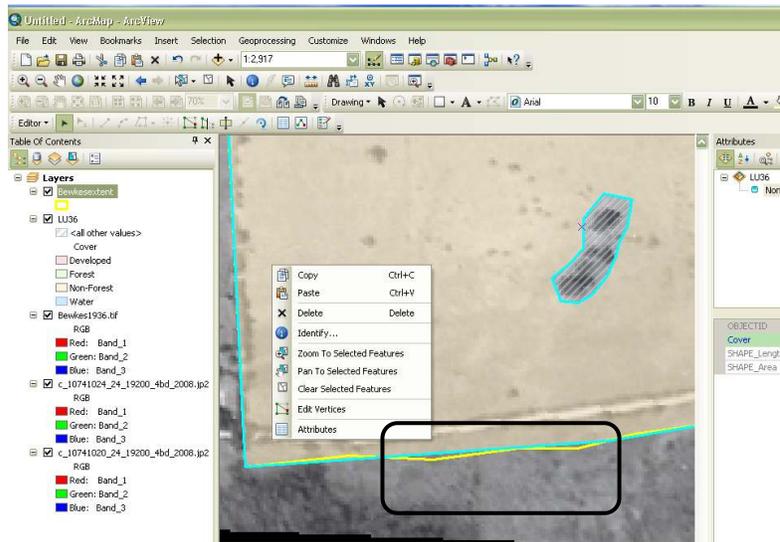


In the window that pops up, select 'Discard the area that intersects' and click open (see below). This will use the selected polygon (the donut hole) to punch out the polygon underneath.



## Modifying existing features

Sometimes you may find yourself in a situation where you need to modify the edge of an existing polygon. For example below my ‘non-forest’ polygon’s boundary doesn’t perfectly fit the study area (see circle). That is, it doesn’t share a common boundary with BewkesExtent.



If you right click on a selected polygon that you want to modify you can select ‘Edit vertices’. Doing so reveals the actual vertices; they will appear green on your screen. Once revealed you can move existing ones as well as creating new ones by left clicking on the line where you want to add one and selecting ‘insert vertex’. Then, you can move them to make the BewkesExtent layer, thus assuring that you cover the entire study area (and nothing else – don’t digitize outside). You will need to click outside the polygon to enact the changes. Pay attention to the snapping information that appears when moving a vertex to assure that you are actually snapping vertices in LU36 to those in BewkesExtent.

Using a combination of the tools above complete your landcover map of the bewkes center. Before you leave lab make sure you are comfortable with the process of digitizing. The exercise will require you to perform a landcover classification on your own.