GEOSPATIAL TRAINING

DIRECTORATE FELLOWS PROGRAM

DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service
NATIONAL CONSERVATION TRAINING CENTER

U.S. Fish & Wildlife Service
National Conservation Training Center
Shepherdstown, West Virginia

Instructors

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U.S. Fish & Wildlife Service; Portland, OR

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U.S. Fish & Wildlife Service; Portland, OR

June 2014


Agenda
1:00 - 2:45
Field Exercise
2:45 - 3:00
Break
3:00 - 6:00
Lab Exercise
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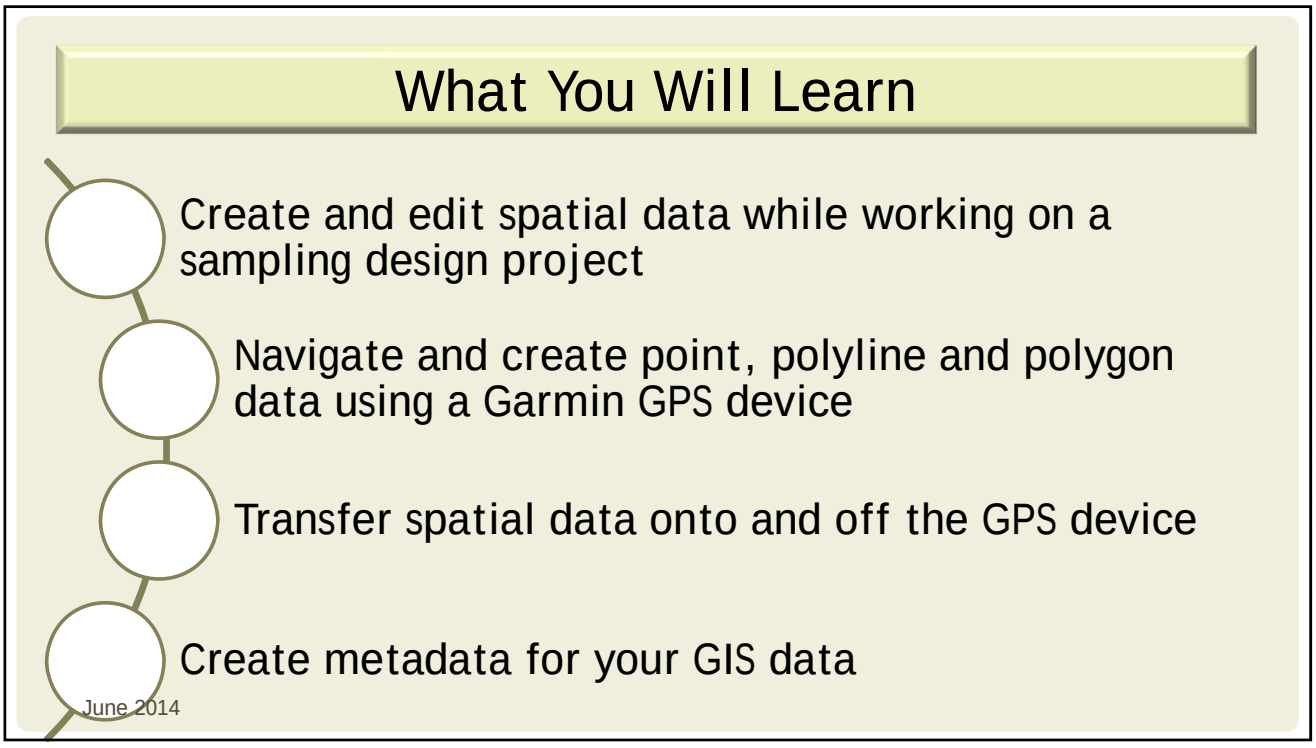
What You Will Learn
Create and edit spatial data while working on a sampling design project
Navigate and create point, polyline and polygon data using a Garmin GPS device
Transfer spatial data onto and off the GPS device
Create metadata for your GIS data
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Materials

Hardware

- GPS Unit
- Exercise

Software

- ArcGIS 10.2
- R
- DNRGPS

Data

- C:\Amazing

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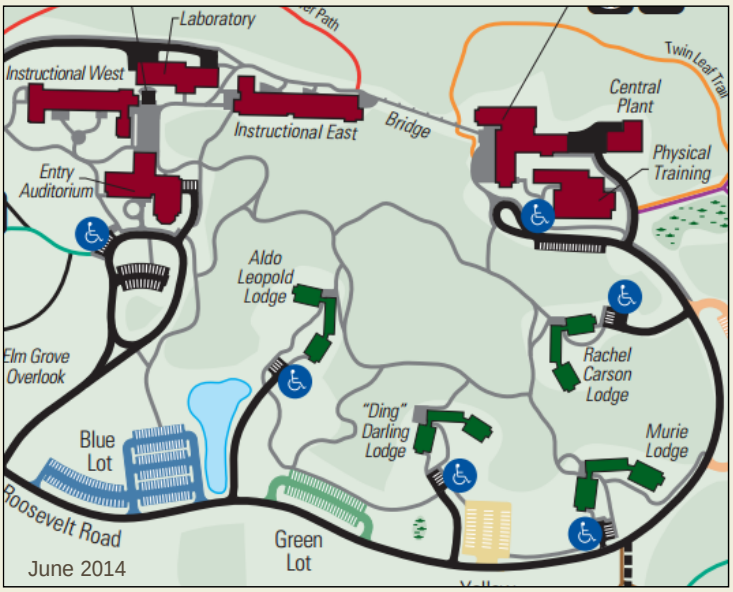
GPS Mapping Field Project



How much asphalt is needed for the inner trails and the Blue, Green & Yellow parking lots?

Some Important Concepts

- GIS Data Types and Models
- Spatial Reference
- Metadata
- Sampling Design

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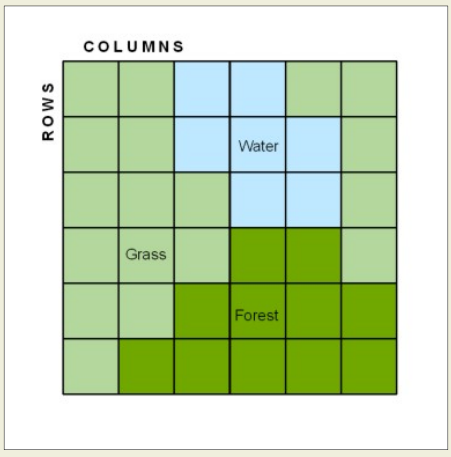
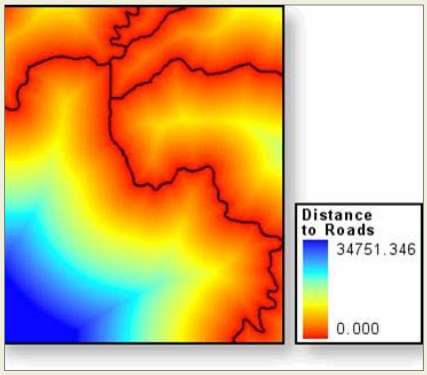
GIS Data Types - Raster





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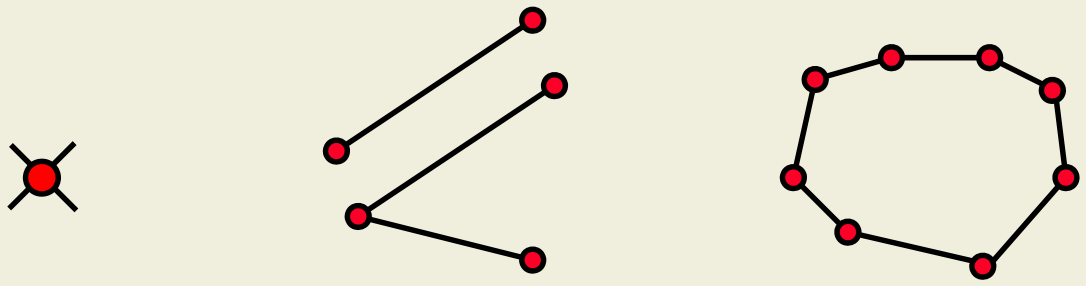
GIS Data Types - Vector



Points **Lines & Polylines** **Polygons**

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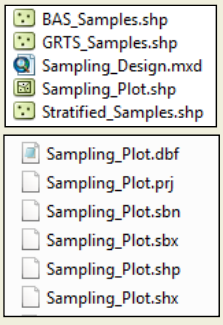
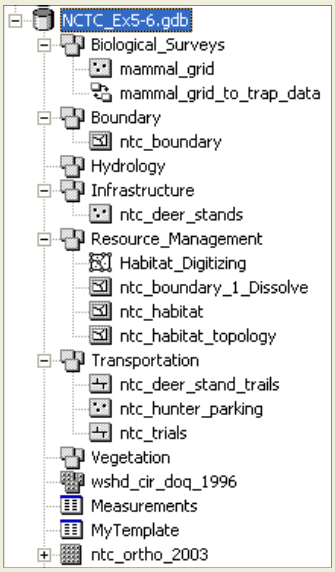
GIS Data Models

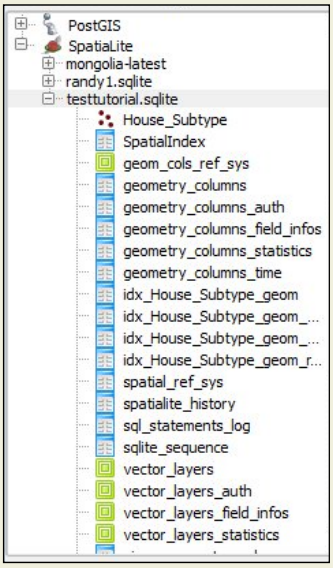
Shapefile



Geodatabase



Geopackage



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Components of Spatial Reference

Coordinate System

Projection

Datum

Transformations

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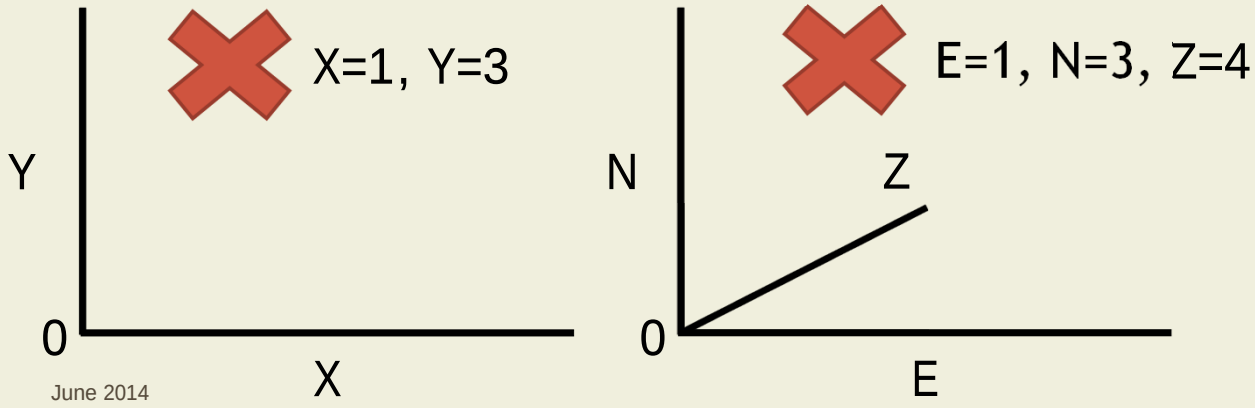
What's a Coordinate System?

A reference frame that ID's a location relative to a known reference point



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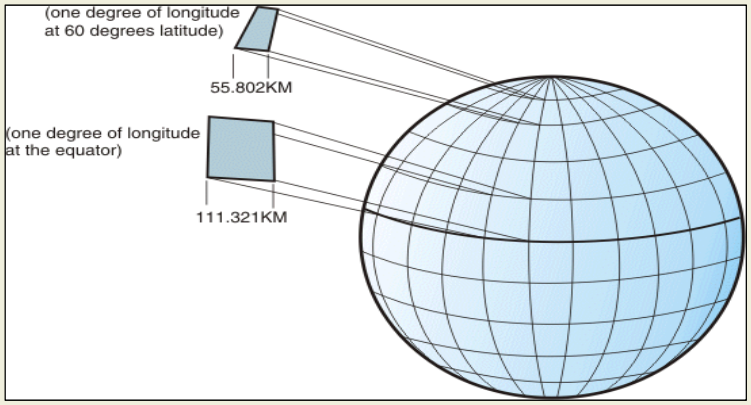
Geographic Coordinate Systems (GCS)

Good for Identifying positions on a globe!

Bad for distance and area calculations.

No uniform units of measure!

Coordinates must be projected to measure area and distance.



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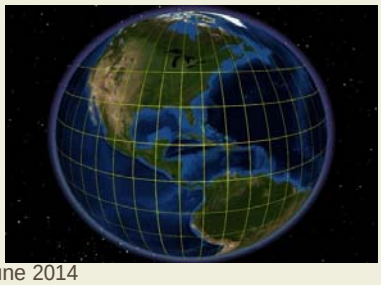
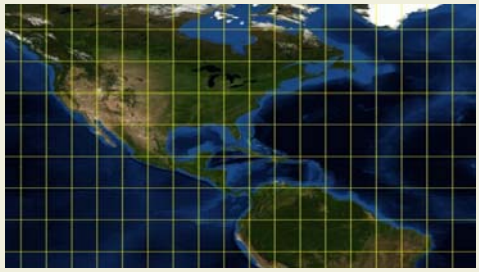
Projected Coordinate Systems (PCS)

A flat 2D surface projected from a 3D globe

Cartesian grid (XYZ) based on a GCS

Distances measured in units of meters and feet





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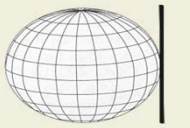
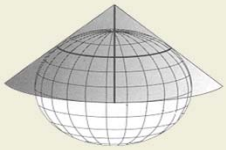
What's a Map Projection?

The cartographic process that flattens the Earth's 3D surface onto a two-dimension map

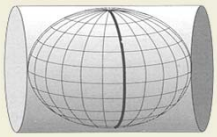
Planar



Conic



Cylindrical



Every flat map misrepresents the surface and distorts area, shape, distance, direction, bearing & scale

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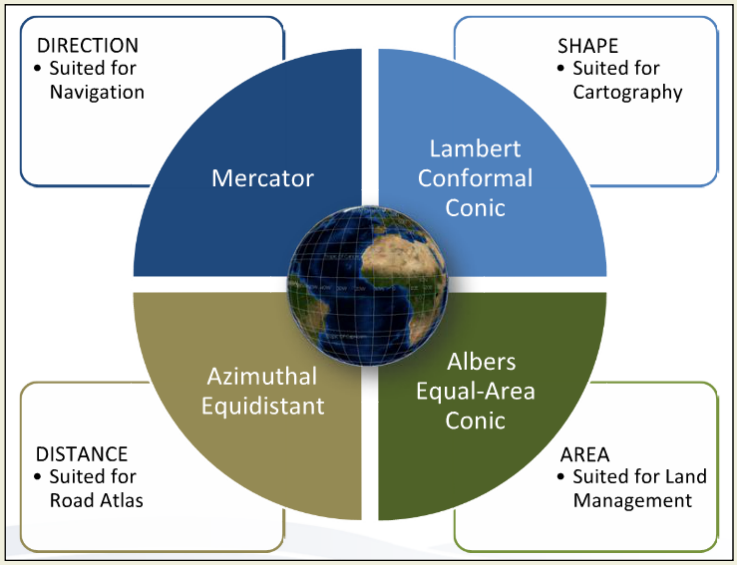
Common Map Projections



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Datum – A Reference Point/Surface

Ellipsoid

Defines the shape and Center of the Earth

Used to ID unknown locations on the earth surface

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Common Earth-Centered Datum's

Datum	Name	Comments
WGS84	World Geodetic System of 1984	The NAVSTAR GPS Datum; WGS84 spheroid
SGS90	Soviet Geodetic System of 1990	The GLONASS GPS Datum
NAD83	North American Datum of 1983	Up to 2 meter difference from WGS84; GRS80 Spheroid
ETRS89	European Terrestrial Reference System of 1989	GRS80 Spheroid

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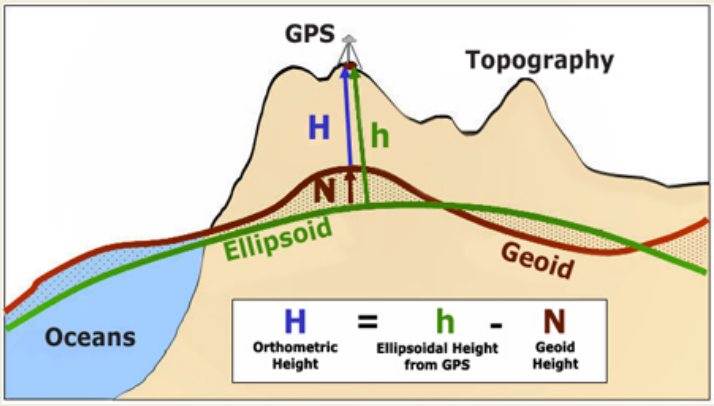
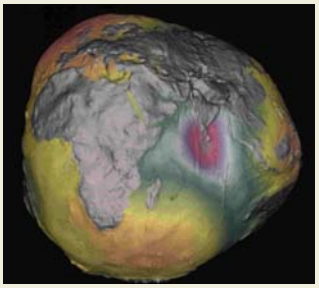
What's your Elevation?



Ellipsoid

Geoid



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Spatial Reference in ArcMap

Is a Coordinate System, Projection in some cases, and a Datum.

If not set, the data frame takes on the spatial reference of the first data set.

```
WGS_1984_UTM_Zone_43N
WKID: 32643 Authority: EPSG

Projection: Transverse_Mercator
False_Easting: 500000.0
False_Northing: 0.0
Central_Meridian: 75.0
Scale_Factor: 0.9996
Latitude_Of_Origin: 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree (0.0174532925199433)
Prime Meridian: Greenwich (0.0)
Datum: D_WGS_1984
  Spheroid: WGS_1984
    Semimajor Axis: 6378137.0
    Semiminor Axis: 6356752.314245179
    Inverse Flattening: 298.257223563
```

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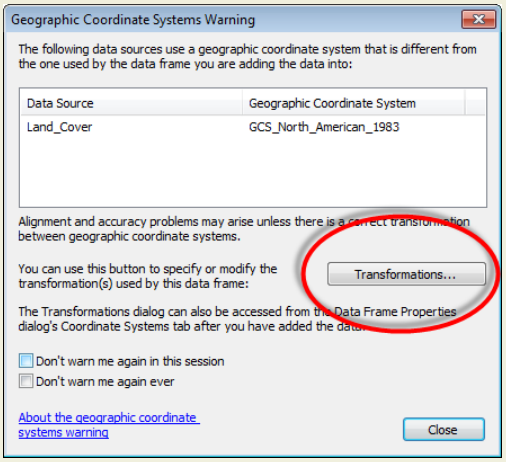
Spatial Reference in ArcMap

- If the added data has a different GCS (i.e., datum), a datum transformation is required (Warning)
- You can either set the transformation in the warning dialog or data frame properties



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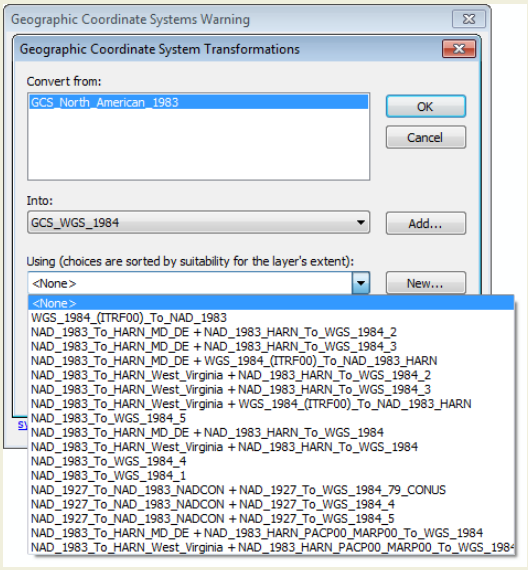
Transformations

Many to chose from, but how do you decide?



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Defining a Spatial Reference

If unknown… you need to figure out what the file is actually stored in first!

- Check the metadata
- Add it to a map with a known projection
- Look at the numbers
- Contact the source and ASK

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What you really need to know

Ensure all layers have spatial reference defined

Be sure the correct spatial reference is defined

Ensure all layers have same spatial reference when performing spatial analysis

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Online Resources

Projection Basics: What the GIS professional needs to know (Article ID 23025, web help)

How to Select the correct datum transformation (Article ID 21327, web help)

NOAA online Training:
http://www.csc.noaa.gov/digitalcoast/training/datums

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Metadata

Don't forget it!

At very least include…

Contact, Purpose & Quality

Else……

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Next Topic - Sampling Design

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Sampling Design - Why Sample?

- A census is impractical or impossible
- Statistical models assume a random distribution
- Reduce BIAS and increase PRECISION in estimates

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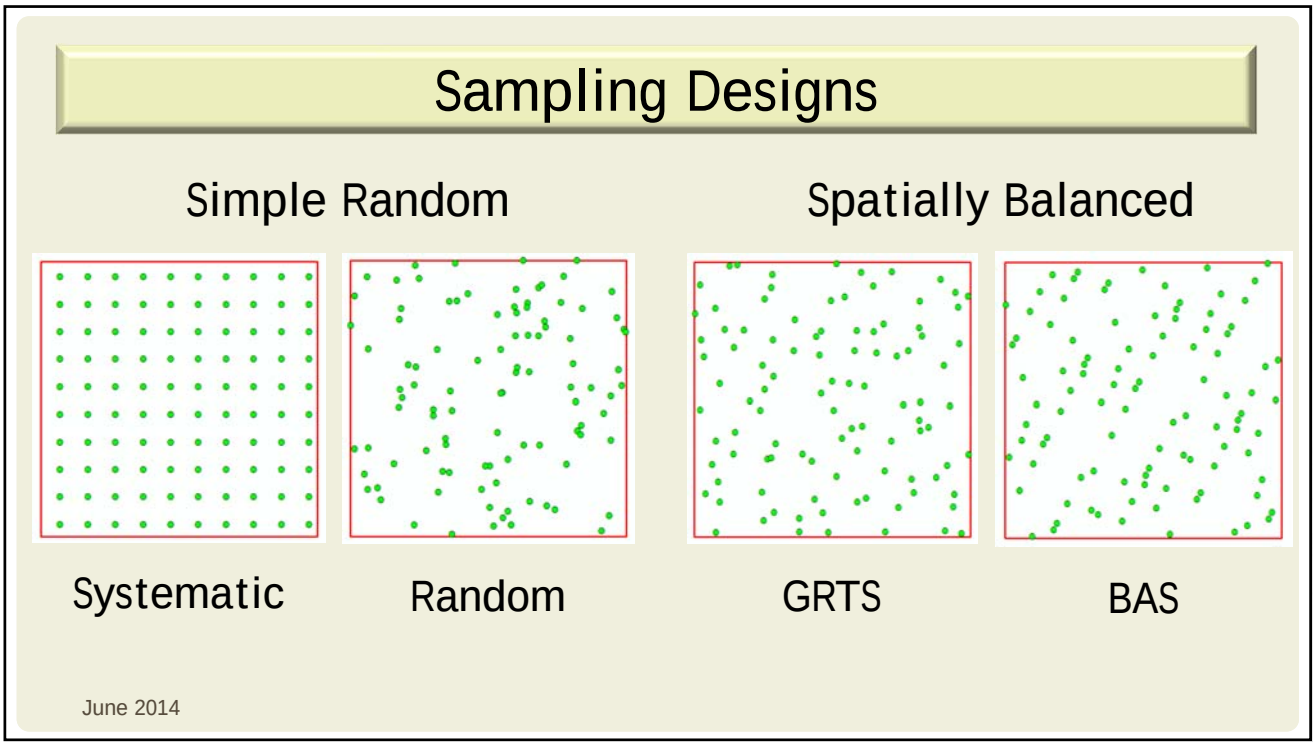
Sampling Designs
Simple Random
Spatially Balanced
Systematic
Random
GRTS
BAS
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Create Sampling Design's Using ArcGIS and R

Session Objectives - At the conclusion of this session you will be able to:

- ❑ Use ArcGIS and R software to create sampling designs for studying wildlife populations and their habitats.
- ❑ Create and edit vector data from a shapefile and geodatabase.
- ❑ Use the cut polygon tool and dissolve geoprocessing tool.
- ❑ Use DNRGPS software to transfer data onto a Garmin GPS device.

Materials created by: Eric Kelchlin (May 2014)

Revision:

Software: ArcGIS 10.2.2, R 3.10, DNRGPS 6.1.05 for ArcMap 10.2

R-Packages (zip files): SDraw_1.01, sp_1.0-15, spsurvey_2.6, spsurveyGUI_1.0, RGtk2_2.20.27,

Directory Path: D:\Amazing

GDB: NCTC.gdb (students create)

MXD: Sampling_Design.mxd (students create)

Imagery: Aerial_2009.sid (UTM 18N, NAD83)

Software Links:

Garmin USB Driver → http://www8.garmin.com/support/download_details.jsp?id=591

DNRGPS 6.1.05 → http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html

Garmin Web Updater* → http://www8.garmin.com/products/webupdater/howtoinstall.jsp

R → http://www.r-project.org/

*The Garmin Web Updater software updates the OS and firmware on your GPS unit. This software is not needed for this exercise, but is very necessary to keep current with updates.

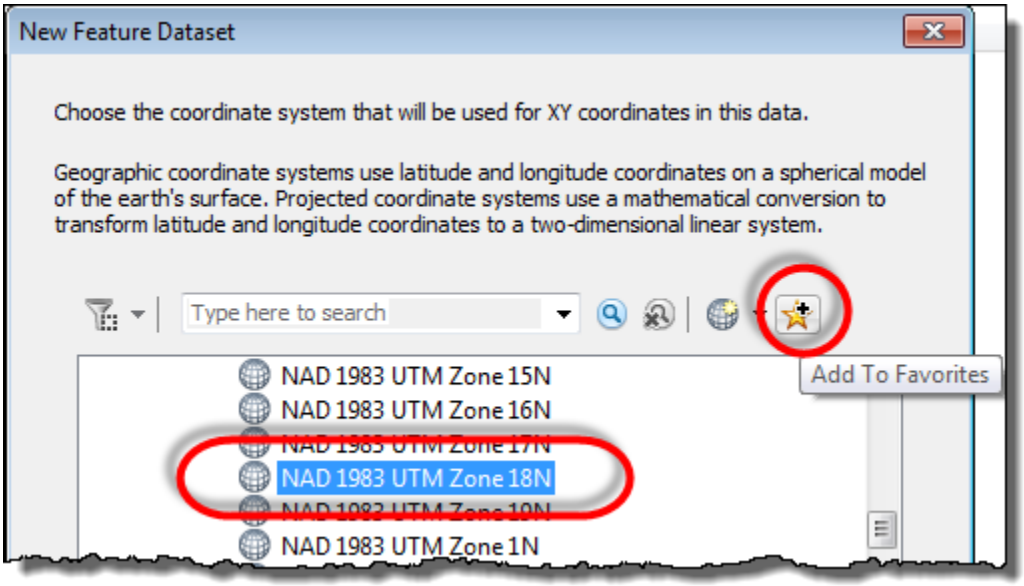
SECTION 1 – Creating Sampling Points

You will be asked to generate sampling points, plots or transects across a study area at some time in your career. With the help of ArcGIS and R statistical software you can easily create a sampling design for a wide array of inventory and monitoring applications. Best yet, you can then upload this data into your GPS unit and laydown the sampling design in the field.

All data are located in the D:\Amazing folder unless otherwise stated.

TASK 1 - Create a New GIS Project

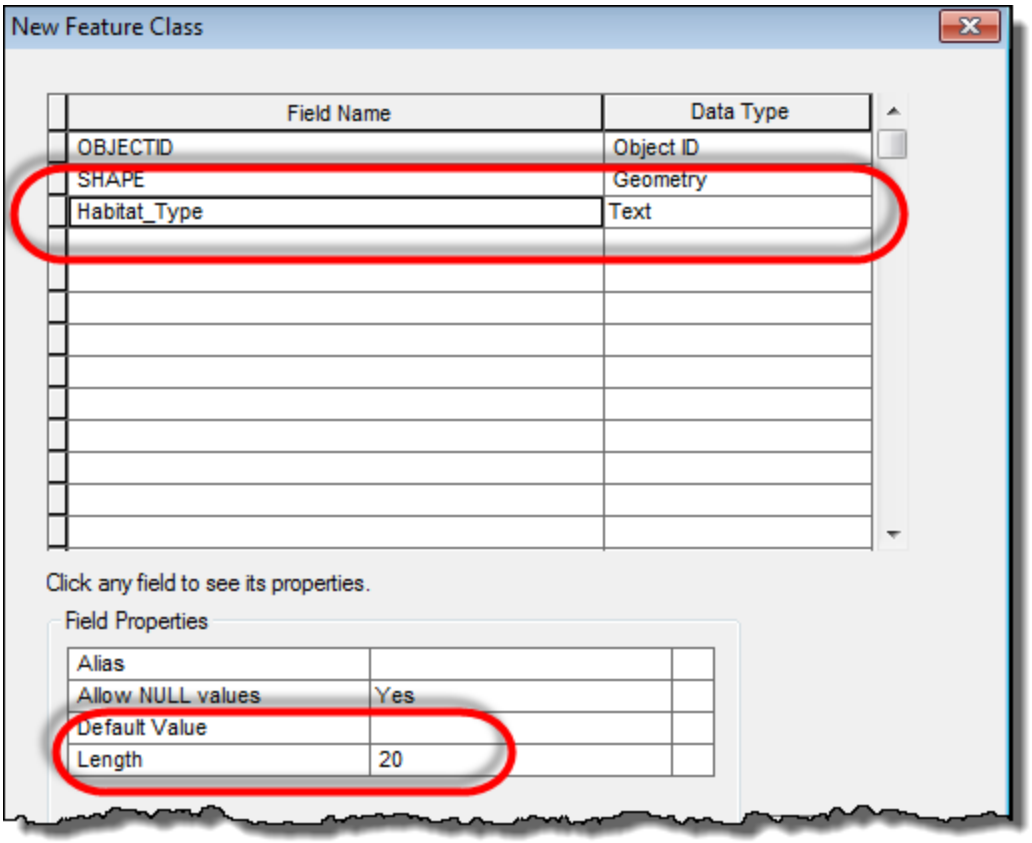
1. Launch ArcCatalog to create a new file geodatabase.
    - Right-click on the **Amazing** folder and select **New > File Geodatabase**.
    - Name the geodatabase **NCTC**.
2. Right-click on the **NCTC.gdb** and create a new Feature Dataset (FDS) and name it **Sampling**. Next, assign the coordinate system.
    - Browse down into the Projected Coordinate System folder and select **NAD 1983 UTM Zone 18N**.
    - Click the Add to Favorites button to bring it to the top for later use.



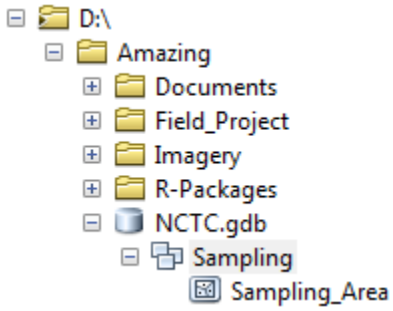
- Click Next twice and Finish to accept the default tolerances.

3. Right-click on the **Sampling** FDS and create a new polygon Feature Class (FC). Name it **Sampling_Area.**

   - Click next twice to get to the attribute table. Create a new text field and name it **Habitat_Type**. Give it a length of **20** characters.

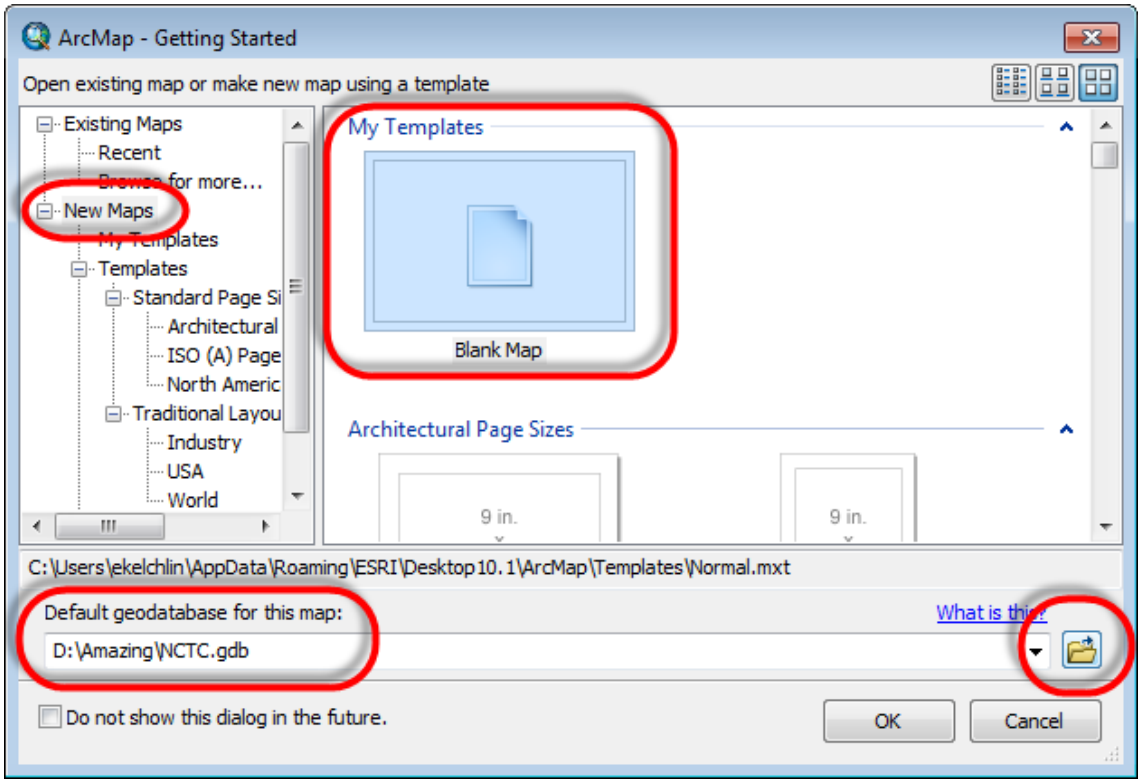


   - Click finish when done. You should now have a file geodatabase that looks like this one below:

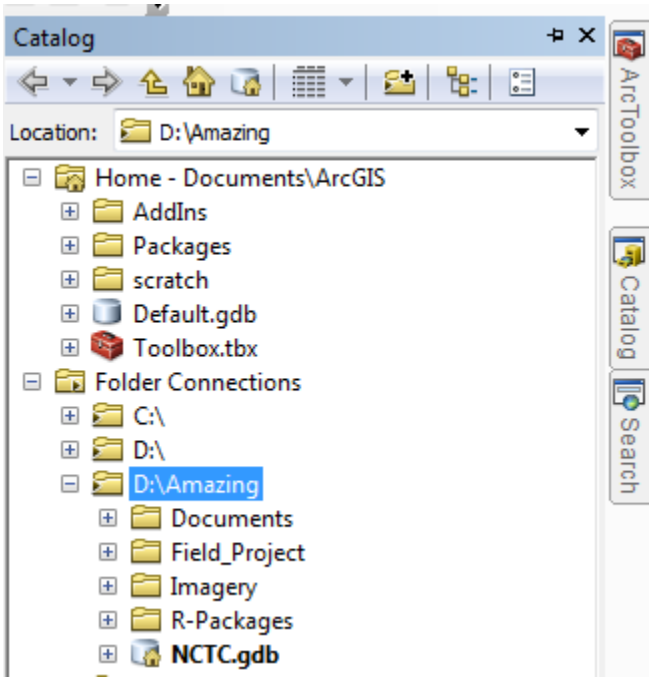


4. Close ArcCatalog and launch ArcMap.

5. Select a new Blank Map document (MXD) and assign the **NCTC.gdb** as our default geodatabase from the Getting Started dialog.



6. Open ArcCatalog from the sidebar and create a new folder connection  to **D:\Amazing** to speed-up our browsing to the project folder.



7. Add data to our blank Data View.

   - Add the **Aerial_2009.sid** file from the Imagery folder by just dragging and dropping the file onto the blank Data View.

   - Add the **Sampling_Area** FC from the NCTC geodatabase.

8. Save the map document and name it **Sampling_Design.mxd**.

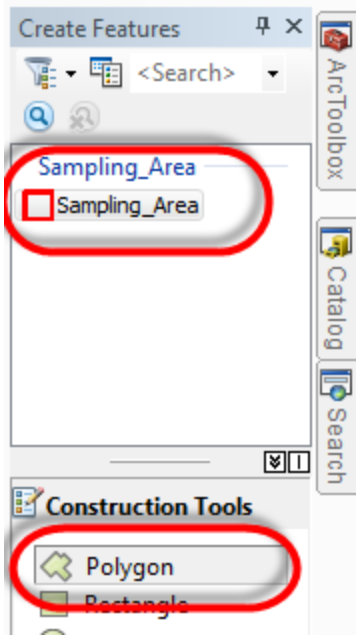
TASK 2 – Define a Study Area

1. Start an editing session and digitize a study area.

   - Click on the Sampling_Area symbol in the Table of Contents (TOC) and change the symbology to no fill color, outline width of 2 and pick a bright color.

   - From the Editor Toolbar, select **Edit > Start Editing**.

   - From the Create Feature dialog, select the **Sampling_Area** FC and **Polygon** in the Construction Tools dialog.



   - Zoom into the center of the image by using the mouse scroll wheel. Scroll forward to zoom in, backward to zoom out. You can also push down on the scroll wheel to grab and realign the image as you digitize.

- Digitize a similar polygon as shown below. Double-click on the last vertices to finish the polygon.

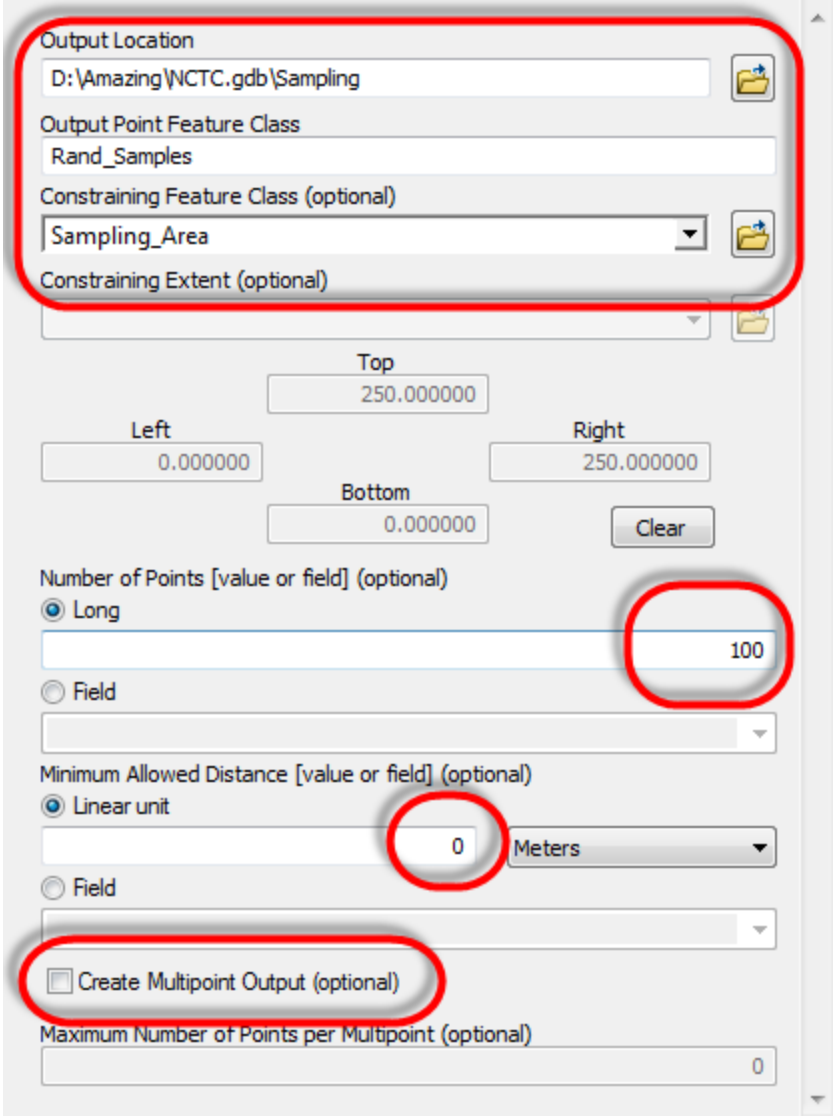
- Save your edits and stop editing (**Edit > Save Edits and Stop Editing**).

TASK 3 – Create Simple Random Samples

1. Randomly distribute 100 points using the Random Tool in ArcToolbox.

   - Open ArcToolbox on the sidebar and browse down to the Create Random Points tool (**Data Management Tools → Feature Class**). Double-click on the tool to launch it. Note: You can easily use the Search tool on the sidebar to find the tool as well.

   - Populate the dialog as shown below and run the tool. Make sure to save the new **Rand_Samples** FC within the Sampling FDS.



2. Notice how the points can be clumped, even on top of each other. This is a known drawback with using the simple random sampling approach. A work around is to change the minimum allowed distance to something other than 0.

    - Run the Create Random Points tool again, but this time change the minimum allowed distance to 3 meters. Name the new FC as Rand3_Samples.

    - Did this improve the clumping issue?

TASK 4 – Create Stratified Random Samples

1. Randomly distribute 100 points across a user defined strata. We'll use habitat type as the strata for this example.

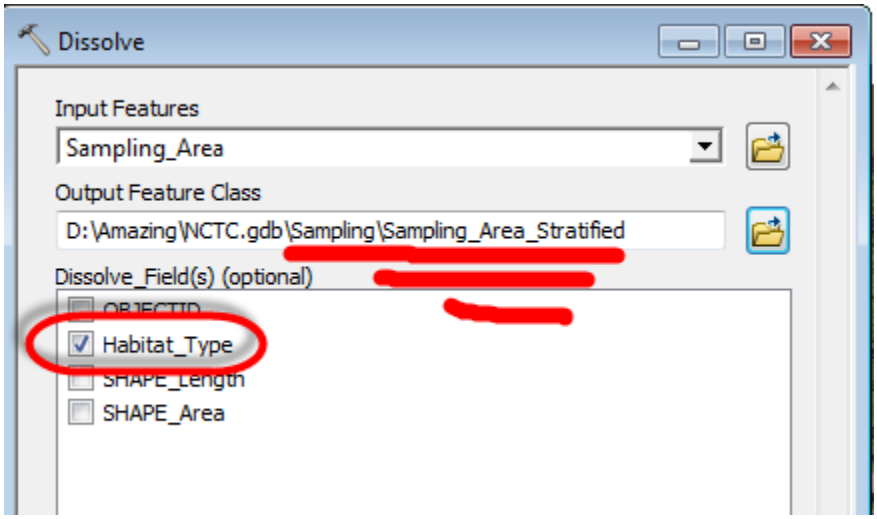
    - Start an editing session and use the cut polygon tool  to create Forest habitat polygons within our study area polygon. The cut tool will make polygons that have no gaps and do not overlap. The instructor will show you how to use the cut polygon tool.

    - Attribute each polygon as either Forest or Grassland.

    - Save edits and stop editing.

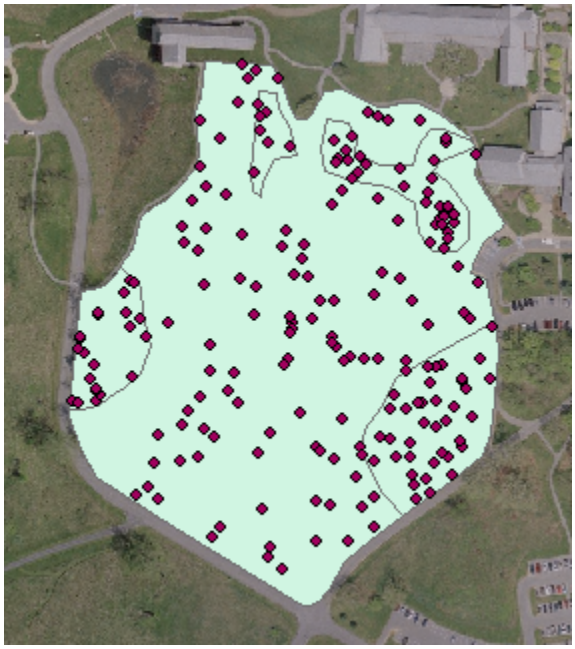
2. Next, use the **Dissolve** tool in the Geoprocessing toolset on the main menu to merge polygons with the same habitat type. This will combine records with the same habitat type in the attribute table, but it will retain unique geometries. This is called a multipart feature.

    - Rename the FC as shown below.



3. Run the Create Random Points tool on your new FC and create 100 sample points among the habitat types.

    - Would the results be the same if we did not use the Dissolve tool before we created the random points?



Challenge Exercise: Notice how the new random points are identified by a number 1 or 2 in the attribute table. It would be nice to have the habitat type names to the attribute table instead of some erroneous numbers. What's a quick way to accomplish this?

SECTION 2 – Sampling Design Using the SDraw Package in R

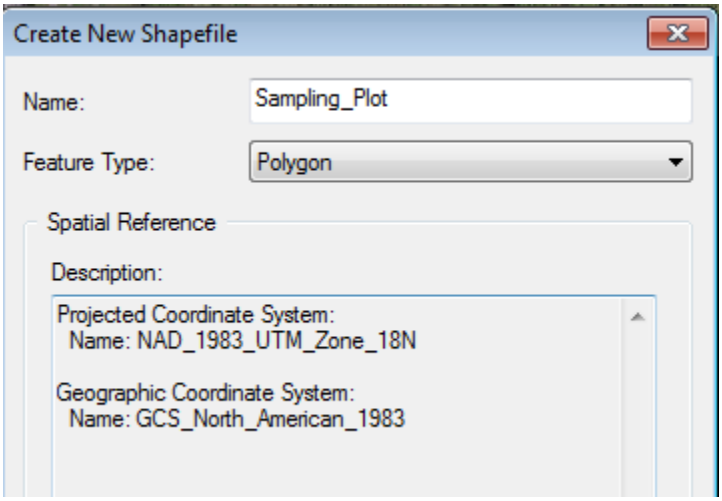
SDraw, developed by Trent McDonald of West Inc., allows you to create systematic samples with ease. But more importantly, SDraw also gives you capability to create spatially balanced sampling designs; this includes BAS (Balanced Acceptance Sampling) and GRTS (Generalized Random Tessellation Stratified) sampling designs. You have a PDF document about BAS in your documents folder. To learn more about GRTS click here: http://science.nature.nps.gov/im/datamgmt/statistics/r/advanced/grts.cfm

TASK 1 – Create a Sampling Plot (Shapefile Format)

1. R does not work with geodatabases, so we need to create a sampling frame that's in a shapefile format. Instead of creating another irregular polygon for this example, let's go ahead and create a polygon with specific geometry like a square sampling plot, grid or quadrat.

    - Open ArcCatalog on the sidebar. Right-click on the Amazing folder and select **New > Shapefile**.

    - Name it **Sampling_Plot** and assign the appropriate coordinate system.



    - Remove all your layers in the TOC except for the imagery and Sampling_Plot.

2. We're going to make a 200 meter square plot.

   - Start an editing session and zoom into  a different section of the campus.

   - Select **Sampling_Plot** in the Create Features dialog to initiate editing, and then select the Rectangle Construction Tool.

   - Left-mouse click once to get the plot started. Drag the mouse down and right-mouse click to view your options.

   - Select Length. Type in 200 and hit the enter key.

   - Right-click one more time, and select Width. Type in 200 and hit the enter key. You should now have a 200 meter square plot.

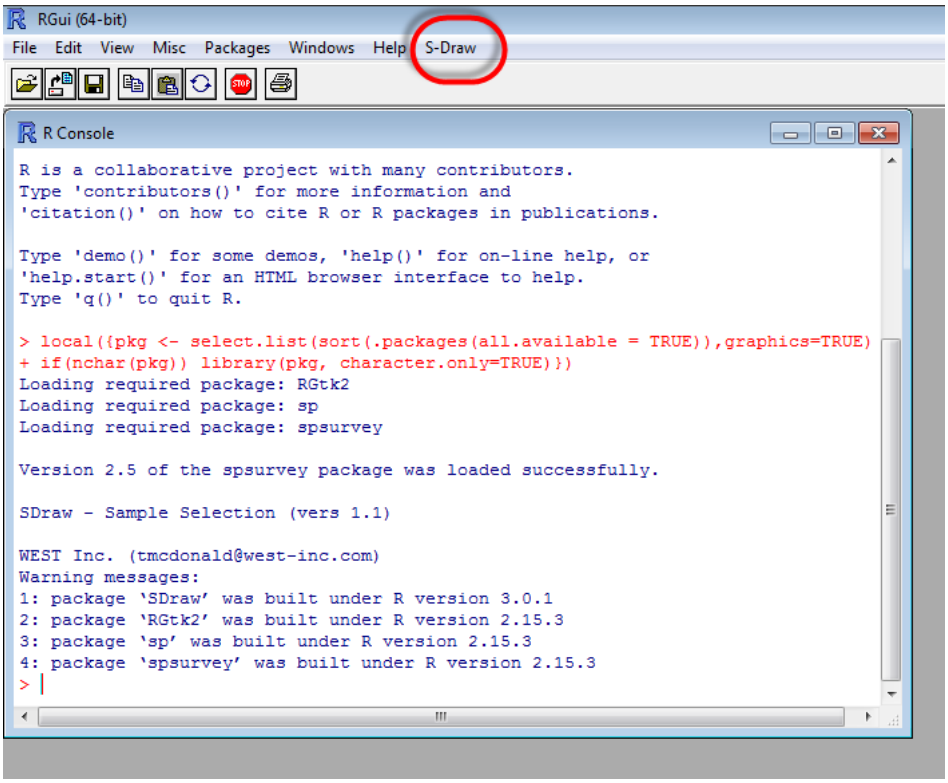
   - Stop Editing and save your edits.

TASK 2 – Working with R

1. Launch R, change the working directory and load the SDraw Package.

   - On the main menu select **File > Change dir** and browse to the **D:\Amazing** folder. We can now access our new shapefile and the outputs will be saved in the working folder.

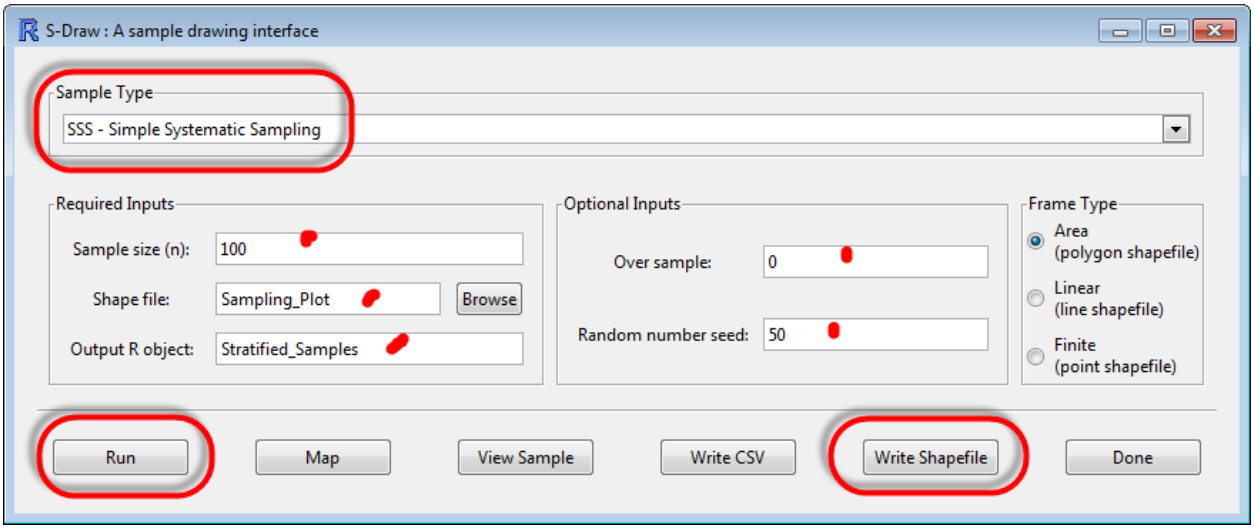
   - Select **Packages > Load package**. Select **SDraw** from the list of packages and select OK. You should now see S-Draw on the main menu. This is unique to R packages, so don't expect a main menu item to appear with other packages.



2. Create a systematic grid of points.

   - Select **S-Draw > Equi-probable Designs**. The GUI may be hidden behind other windows, so may have to go fish for it.

   - Change the Sample type to SS–Simple Systematic Sampling and populate the rest of the fields as shown below.



- Click Run to create the dataset, then Write Shapefile to create the shapefile. Leave the GUI open.

3. Create BAS and GRTS sample of points.

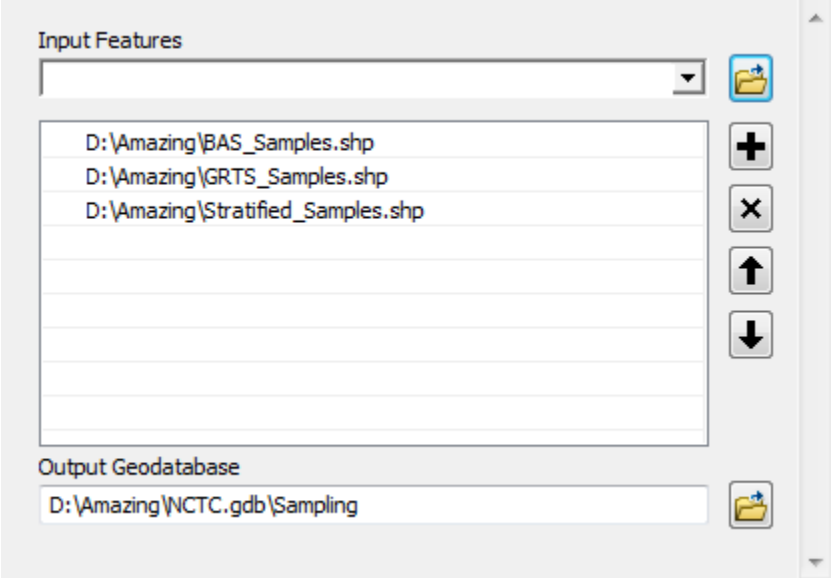
   - Change the Sample type to BAS.
   - Change the Output object to **BAS_Samples**. Keep the rest of the fields the same.
   - Run the tool and Write the Shapefile.
   - Change the Sample type to GRTS and repeat the process. Name the file **GRTS_Samples**.
   - Click Done and exit out of R.

TASK 4 – Import the Shapefiles into the Geodatabase and View the Results

R does not create projected shapefiles. However, we know the spatial reference is NAD83 UTM18 because we assigned it to our Sample_Plot shapefile. A quick way to provide a spatial reference for these files is to import them into our Sampling FDS. Any layer imported into a FDS will be automatically assigned the spatial reference of the FDS.

1. Import the shapefiles and convert them into feature classes.

    - Open ArcCatalog on the sidebar and right-click on the Sampling FDS in the NCTC geodatabase.
    - Select **Import > Feature Class (multiple)…**
    - Add the three shapefiles and click OK.



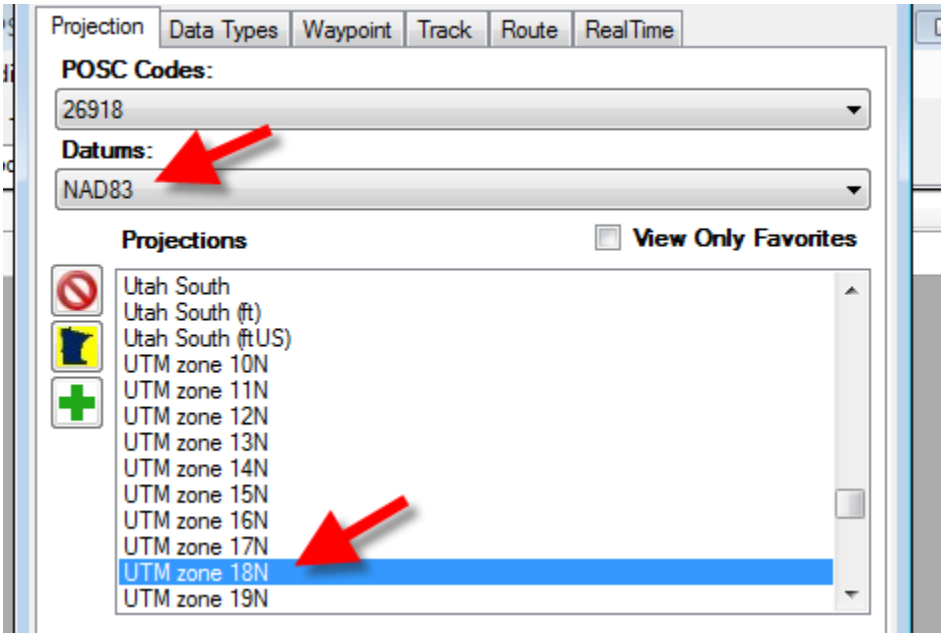
    - View your sampling points. How do the distributions look?

SECTION 3 – Uploading the Data into the Garmin Map76CSx

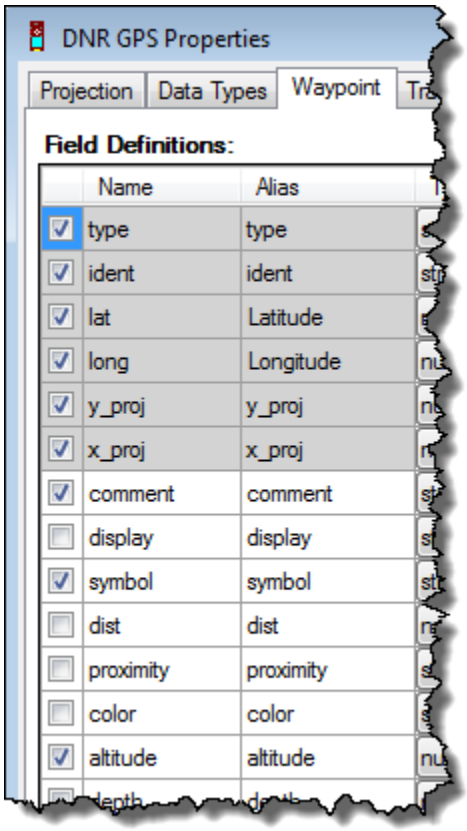
In this section you will be using DNRGPS to upload the **Sampling_Plot** shapefile and the **BAS_Samples** FC you just created.

TASK 1 – Delete GPS Data and DNRGPS Setup

1. Delete all the data on your GPS unit first before you upload any new data.
    - Turn on your GPS unit and go to the Altimeter Page from the Main Menu.
    - Select the Menu button once to bring-up the page specific menu.
    - Select Reset on the list, then scroll down to Select All, then scroll down and hit Apply. This will remove all waypoints and tracks in one fell-swoop.
2. Attach you're Garmin unit to the computer via the USB cable.
3. Launch DNRGPS from the desktop.
4. Change DNRGPS Default Settings.
    - Set your projection to NAD83 UTM18N (**File > Set Projections**).



- Set your waypoint properties so that comments, symbol and altitude are the only optional fields shown (**Waypoint > Waypoint Properties**). Mandatory fields are gray.



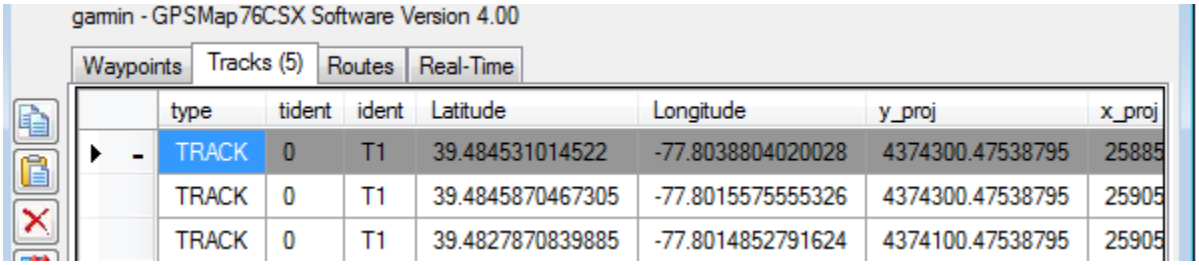
- Set your track properties so that comments and altitude are the only optional fields shown (**Tracks > Track Properties**).

TASK 2 – Uploading Shapefiles

1. Load the shapefile first by Selecting **File > Load From > File** from the main menu.

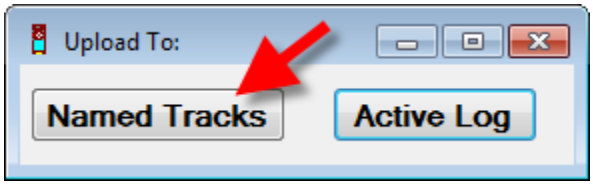
    - Browse to the Amazing folder, select **Sampling_Plot** and click OPEN. If you don't see the file, change the file type to ESRI Shapefile 2D.

    - Click OK to accept Id as the TIDENT field. You screen should look similar to the one below.



2. Next, select **Track** on the main menu and click **Upload**.

    - Select Named Tracks and OK. You could go either way, but it would be better to have the tracks saved separately for easier access.



3. Go to the Map Page on the GPS unit to view your data. This is always a good idea before you head-out into the field. Make sure your data is on the GPS unit, and in a way that you expected it to be. Garmin loves to connect uploaded polygons because it treats lines and polygons as tracks.

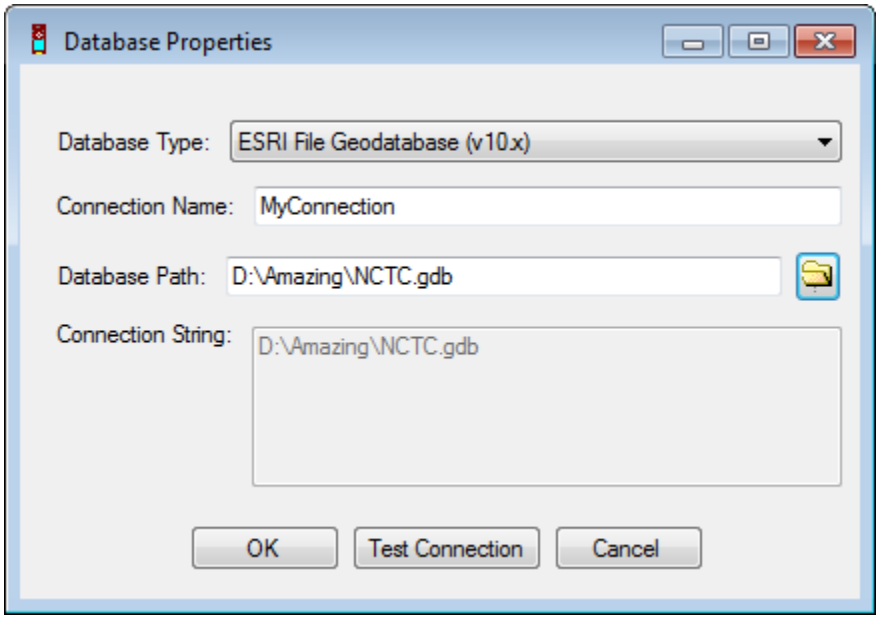
    - If you don't see your track on the Map Page, then tap Menu Menu twice and select to the Tracks icon. Scroll down the saved tracks section and select your track. Hit the Enter Key and select the Map button at the bottom right of the dialog. You'll be sent the location of the track on the Maps Page.

TASK 3 – Uploading Feature Classes

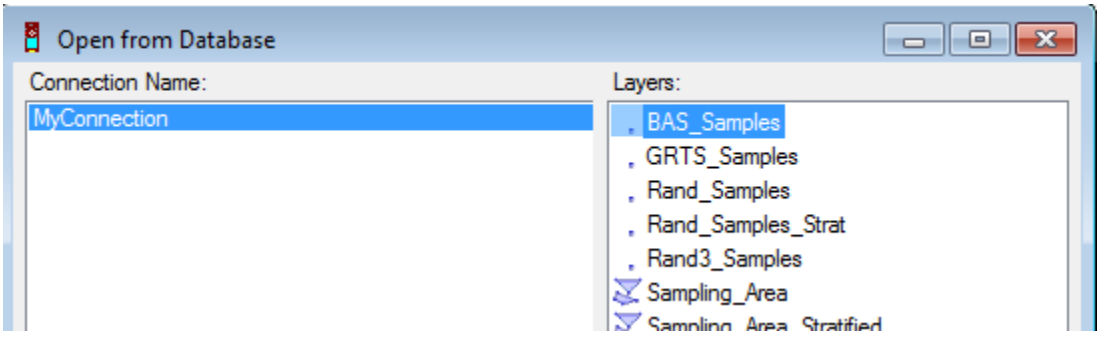
1. Upload the **BAS_Samples** point FC. The process is more involved than uploading a shapefile. To upload a FC you first have to connect to the database.

   - Select File > Load From > Database. Click Add.

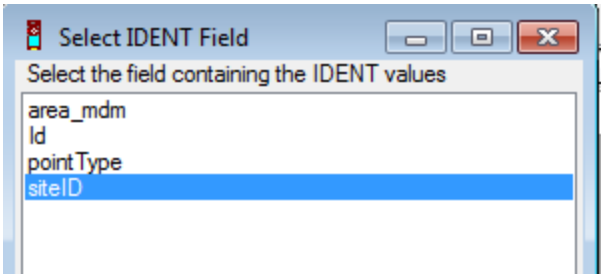
   - Change the fields to what is shown below. Test the connection and click OK.



   - Select the **BAS_Samples** FC and click OK.



   - Finally, select the **SiteID** for the IDENT values and click OK.



- Select **Waypoint > Upload** to copy the points over to the GPS unit.
- Look at the map page on the GPS unit and see if all the points made it over.

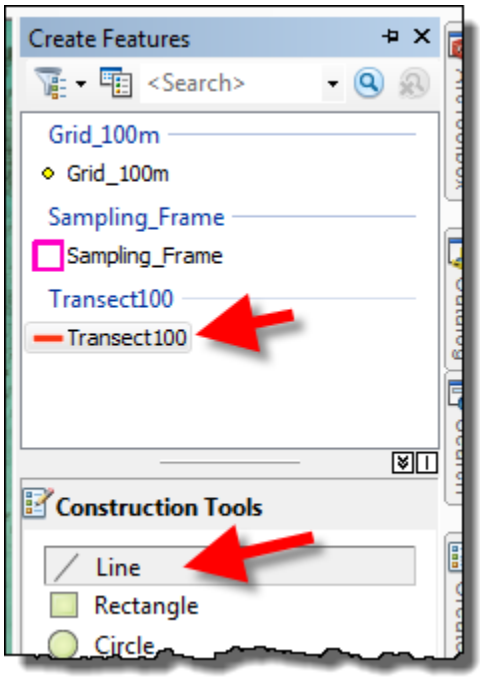
APPENDIX – How to Create Sampling Transects

In this last section were going to create 100 meter long transects and generate systematic points along these transects. This sampling design is often used for bird point count transects and point-line-intercept vegetation surveys.

1. Create a new line feature class and name it **Transect100**.

2. Change the symbology of the line to better see the line as it's digitized on the on the imagery. I chose the Highway Ramp symbol.

3. Start an editing session and create the 100 meter long transect.



- Left-mouse click once on the image. Drag the mouse down and right-mouse click. Select Length in the pop-up menu. Type 100 and hit Enter on the keyboard.

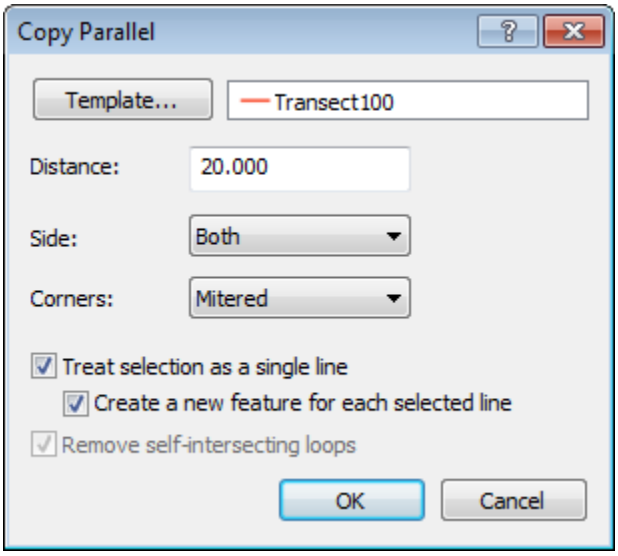
- Drag the mouse in the direction you want the transect follow and left-mouse click to create the second point.

- Right-click and select the Finish Sketch  button on the Feature Construction Toolbar, and you're done.

4. Make two more 100 meter transects that run parallel to the first using the Editor Toolbar.

   - Click on the Editor button on the Editor Toolbar and select Copy Parallel.

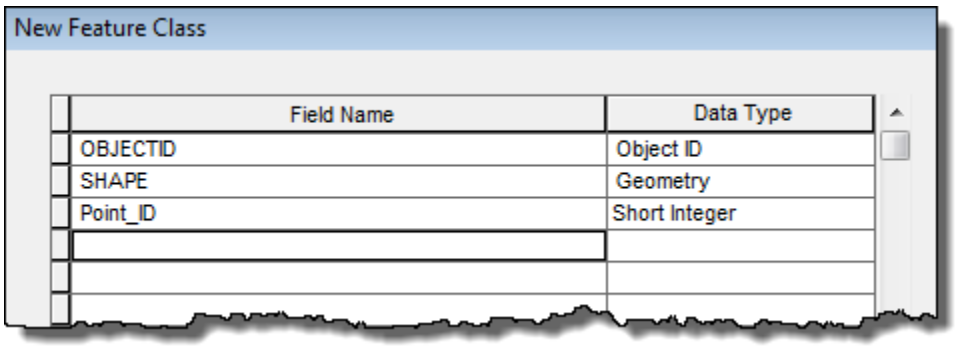
   - Use a 20 meter distance shown below and click OK. You should now have 3 transects, each one paralleling the other at a 20 meter distance.



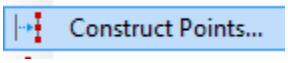
   - Stop editing and save edits.

5. Finally, we're going to add sampling points at regular intervals along each transect.

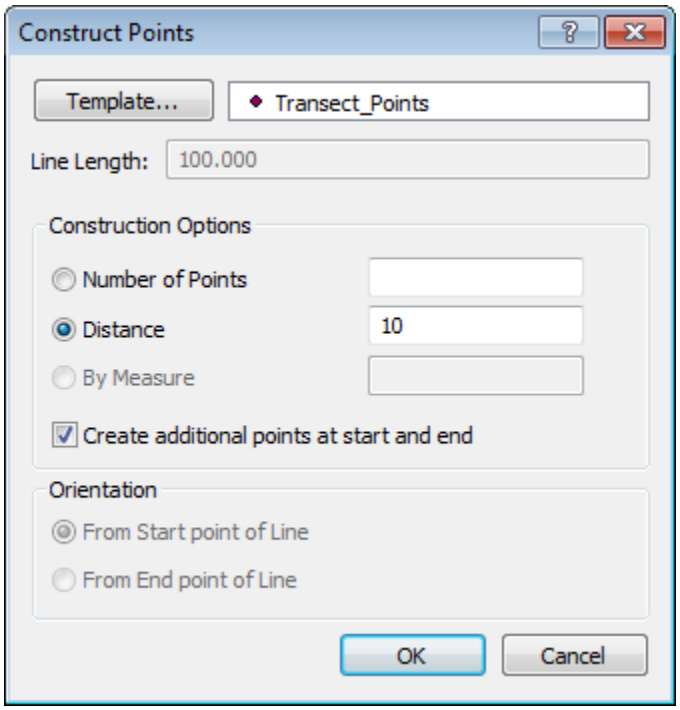
   - First, create new point feature class and name it **Transect_Points**. Create a short integer field in the attribute table and title it **Point_ID.** We'll use this field for labeling the points later on.



- Start a new editing session.
- Use the Editor Tool arrow  to select one of the transects.
- Click on the Editor button and select **Construct Points**.



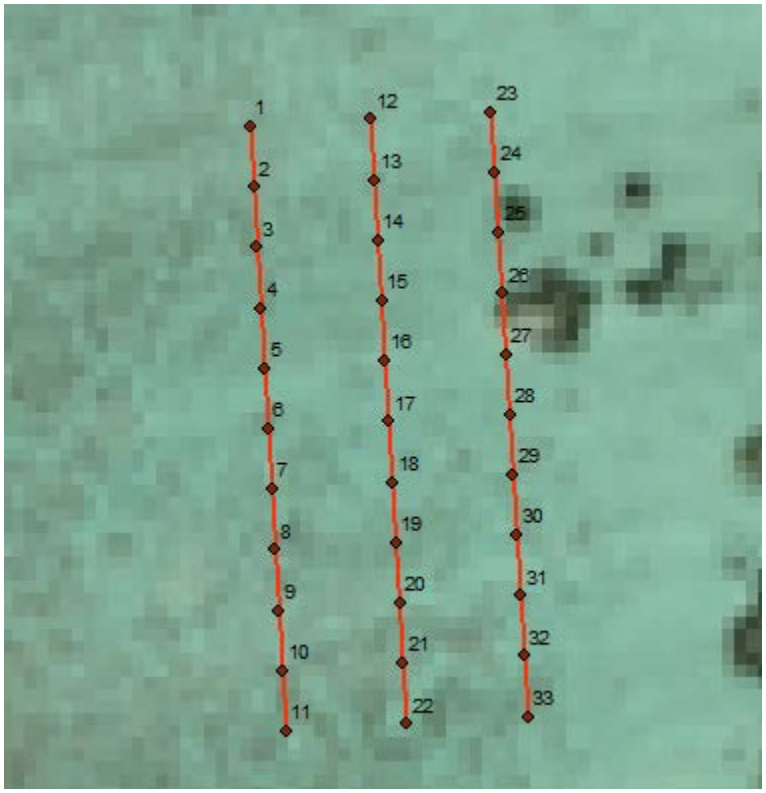
- Create a point every 10 meters, starting from the beginning of the transect. See the example below. Make sure you're using the right Template.



- Repeat this process for the other two transects.

6. Label the **Transect_Points** layer using data from **Point_ID** field. But, first create the data!

- Open the Transect_Points Attribute table and use the Field Calculator to create a sequential list of numbers in the Point_ID field.
- Right-click on the Transect_Points layer and select Label Features.
- Change the field to Point_ID in the layer Properties if needed.



7. Stop editing, save edits, save the map document (MXD) and close ArcMap.

Challenge Exercise: Create another transect and add points to the line at RANDOM distances. What tool(s) did you use_____?

Team GPS Mapping Project

Session Objectives - At the conclusion of this session you will be able to:

- ❑ Conduct a multi-user GPS project
- ❑ Import GPS field data into a geodatabase
- ❑ Edit line and polygon data in ArcMap 10.2 using advanced editing tools
- ❑ Calculate length and area using the Calculate Geometry function
- ❑ Create holes in polygons using the Erase Tool
- ❑ Quickly create metadata

Materials created by*:* Eric Kelchlin, August 2011

Revision: May 2014

Software: ArcGIS 10.2.2, DNRGPS 6.1.05 for ArcMap 10.2,

Directory Path: D:\Amazing\Field_Project

Documents: Infrastructure_Project_Summary.docx

GDB: NCTC_2.gdb

MXD: GPS_Mapping.mxd

Imagery: Aerial_2009.sid (UTM 18N, NAD83)

GPS Project Summary

Title: NCTC Infrastructure GPS Mapping Project

Requested by: Joe Maintenance (joe_maintenance@fws.gov)

Problem Statement:
NCTC has a network of paved trails and parking lots. Facilities Operations would like to map the paved trails to determine how much paving material would be needed for a complete replacement in the near future. They would also like to determine how much asphalt would be needed to replace the large parking lots. A team approach will be necessary to speed-up the data collection process due to time constraints. The trail segments should be merged into one layer with no dangles and gaps. The parking lot will need to have the islands completely removed from the polygon to not overestimate the asphalt area. Finally, Joe's supervisor requires that metadata be completed for all GIS layers due to high employee turnover.

Objectives & Methodology:
1. In teams of 2, collect the polyline or polygon features using a Garmin Map76CSx. Use a 2 second logging rate.
2. Download the GPS data using DNRGPS from both GPS units onto one computer and save the data as a line or polygon feature class in the NAD83 UTM18 projection.
3. Using the Editor Toolbar and Advanced Editing Tools, remove line dangles and gaps and then merge the trail segments into one layer.
4. Multiply by a trail length of 1.2 meters in width to calculate the area in square meters.
5. Remove the islands from the parking lot polygon using the Erase Tool.
6. Add an Area (square meters) field in the Parking Lot attribute table and use the Field Calculator to find out how much materials are need to pave the parking lots to a 10 inch depth (0.254 meters).
7. Copy and paste this GPS project summary into the Description field of the metadata.

Existing Data:
- GPS_Mapping.mxd and imagery

Deliverables:
1. To answer the question: how much paving material is needed for the trail and parking lot (square meters).
2. A "clean" trail and parking lot feature class with length and area calculations in the attribute tables.
3. Metadata with the GPS project summary in the description field.

Items to Keep in Mind

1. This exercise is purposely designed to push you're GIS and GPS skills into uncharted territory…so don't be shy to ask the instructor or team member for help.

2. This is a team project, so work together to collect the field data. Divide up the work load, but smartly.

3. You have to decide where to start and stop the trail or perimeter of the parking lot. You can't just turn the GPS unit on and walk….the result will be a connected spider web of overlapping useless data. Map in segments and save results after each segment.

4. When creating polygons (i.e., area features) in the field, you don't want to start and stop in the same location. Find a starting point at the end or beginning of a straight section. End the polygon well before the starting point and the polygon will snap shut. This will save you time and give you nice strait lines where you want them.

SECTION 1 - Downloading Field Data Using DNRGPS

All data are located in the Amazing\Field_Project folder.

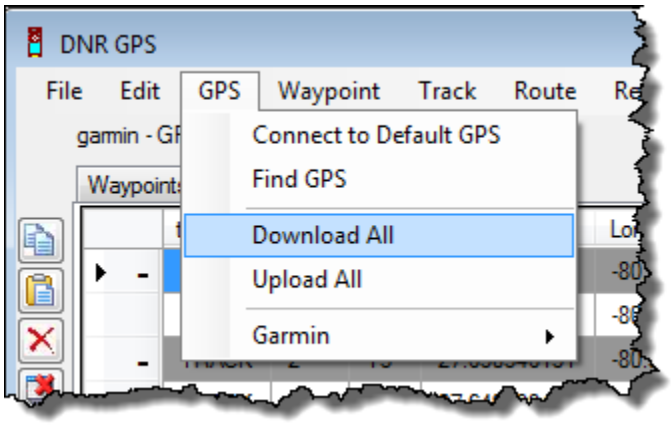
1. Launch ArcMap and open the GPS_Mapping map document.

2. Turn on the GPS unit and attach your GPS unit to the computer using the USB cable. Be careful with the earflap on the back of the GPS unit….it will come off!

3. Launch DNRGPS. The model of the GPS unit will be shown just below the main menu after a few seconds indicating the connection has been made.

4. Make sure you have the proper projection set (File>Set Projection).

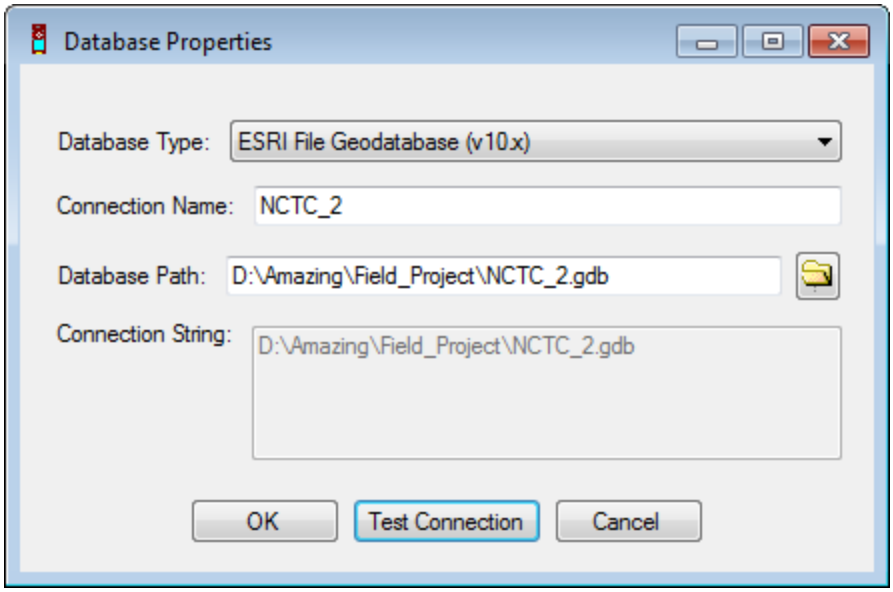
5. Download the waypoints and tracks (e.g., lines and polygons) at one fell swoop by selecting **GPS > Download All**. You can do waypoints and tracks individually under each respective button, but this method is quicker.



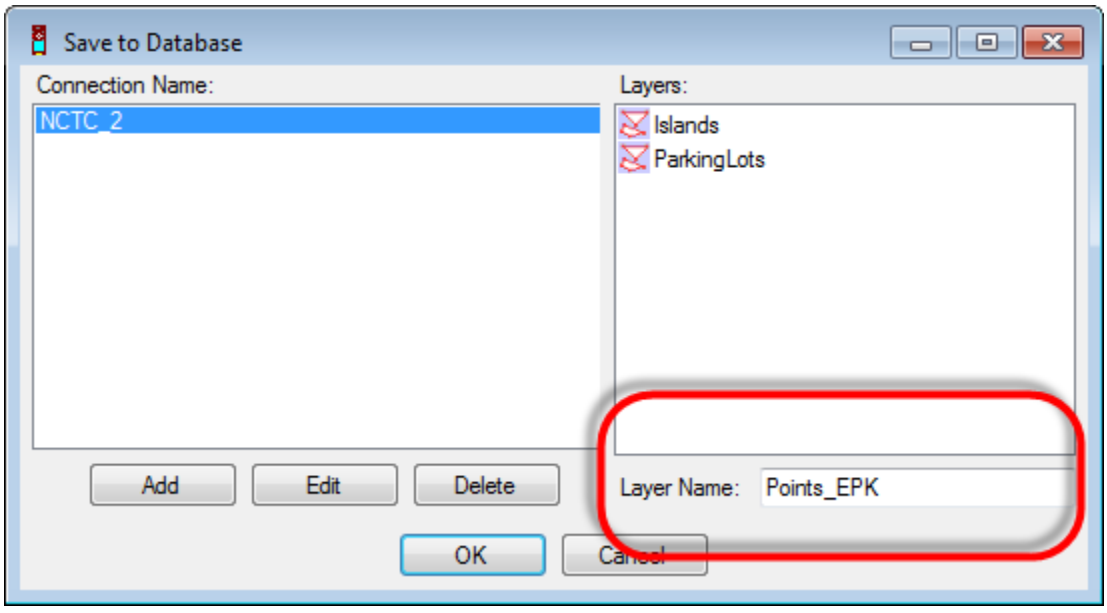
6. **Saving Waypoints as a Feature Class-** select the Waypoints tab just above the table to view all your waypoints.

   - Select **File > Save To > ArcMap > Database**

   - Click Add to add a connection to the geodatabase. Browse to the **NCTC_2.gdb**. Your dialog should look like the one below.



- Test your connection and click OK.
- Save the waypoints as **Points_"your initials"**. Click OK.



- Your data should show-up in the TOC in ArcMap.

7. **Saving lines or polygons as Feature Classes -** click on the Tracks tab just above the table to view your tracks.

    - Select only your named tracks with the click and Shift Key technique.
    - Save the files as feature classes as shown in step 6.
    - Name the tracks **Trails_"your initials", Parking_"your initials"** or **"islands_"your initials"** depending on your project. Save your parking lots and islands as separate polygon feature classes.

Notes on Active and Named Tracks: the active tracklog is everything that you saved or not saved. It's a record of everything you collect once you turn on the tracks from the tracks page or click enter on the area calculation page. If you saved a track, then the active tracklog has a duplicate. So, if you download all your tracks and save them without regard of the type of track, then you will have duplicates. Be careful!

SECTION 2 – Trail Team Project

This section illustrates some common editing tasks in ArcMap that are often utilized to clean-up GPS line and polygon data. Your objective is to connect all the line segments together, remove dangles and gaps. You can also adjust any poor data locations using the background imagery as a reference. You might only need to perform a couple tasks.

TASK 1: Set the Stage

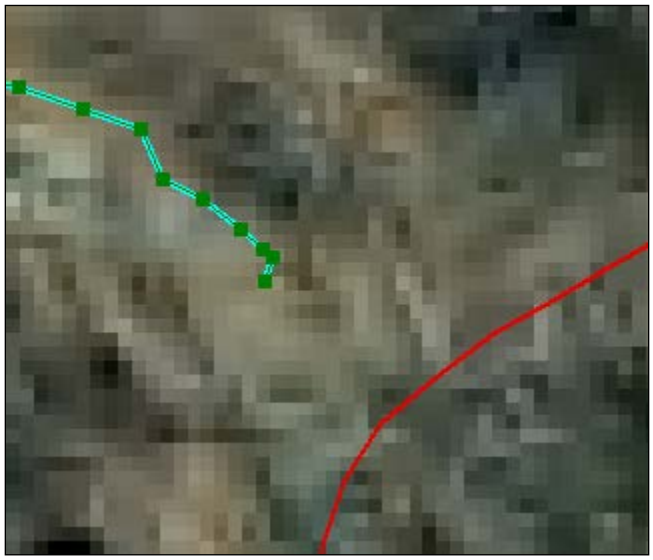
1. Right-click in the "gray area" on the main toolbar in ArcMap and select the **Snapping** and **Advanced Editing** Toolbars. Move the toolbars to a desired location.

2. Click on the **Snapping** drop-down arrow and make sure Use Snapping is checked.

   - Make sure all 4 snapping buttons on the toolbar (Point, End, Vertex and Edge) are depressed.
   - On the Editor Toolbar, select the **Snapping > Options** and set the snapping tolerances to 10.

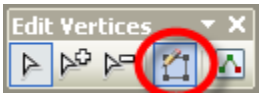
TASK 2: Connect Broken Lines

1. Start an editing session by selecting the drop-down arrow on the **Editor Toolbar** and select **Start Editing**.
2. Click on the Edit Tool  on the Editor Toolbar.
3. Zoom into  the area you will be working in.
4. Using the **Edit Tool**  , double click on the line that you want to edit to show its vertices (green boxes).



5. Place your mouse over the last vertex until it becomes a box surrounded by arrows. Left click and drag the vertex to the desired location on the other line. Notice how the vertex "snapped" to the edge of the other trail.

6. Click on the **Finish Sketch** icon on the floating **Edit Vertices** toolbar or anywhere on the map to accept your changes.



7. If you make a mistake, use the undo button on the **Standard** toolbar.

8. To insert a vertex, click on the Insert Vertex tool on the **Edit Verticies** toolbar.

9. To delete a vertex, click on the Delete Vertex tool on the **Edit Verticies** toolbar.

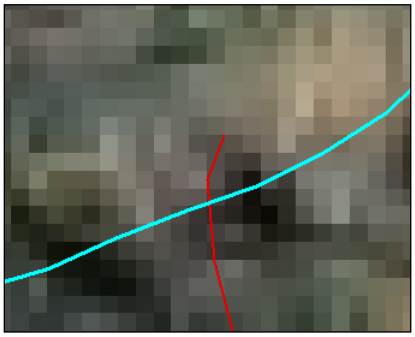
TASK 3: Trim lines

1. Zoom in  to the area you will be working in.

2. Use the Edit tool  to click once on the line which will be used to trim the desired line. We will trim the red line where it crosses the selected (blue) line.

3. Click on the Trim tool  on the **Advanced Editing** toolbar.

4. Now, click on the red trail line above the blue selected trail to remove the overshoot.



TASK 4: Split lines

This is a useful tool when you have to a lot of vertices to delete and you don't want to waste your time deleting each one separately. The split tool cuts the line so you can delete entire line segments.

1. Zoom in  to the area you will be working in. Highlight the trail to split with the Edit tool  .

2. Click on the Split Tool  on the **Editor** toolbar.

3. Click on the line where you want the split to occur. Select the line segment you want to delete and press the **Delete** Key.

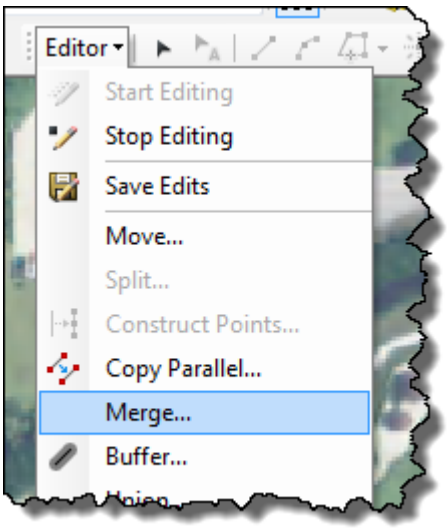
TASK 5 - Calculate Trail Length and Area

1. Merge all the trail segments into one multi-part polyline after you're done with the line edits.

   - Right-click on the Trails layer in the TOC to open the attribute table. Select all the trail segments while still in edit mode.

   - Click Merge in the Editor Toolbar. (Note: you can also use Dissolve in the Geoprocessing Tools to merge the lines into one multi-part line and create a new FC in one step.)

   - Save edits and stop editing.



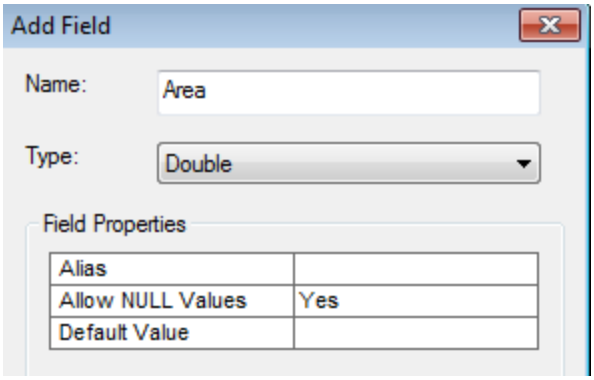
2. What's the total length of the Trail in meters_____?

3. To calculate area we need to add a new field first then run the field calculator.

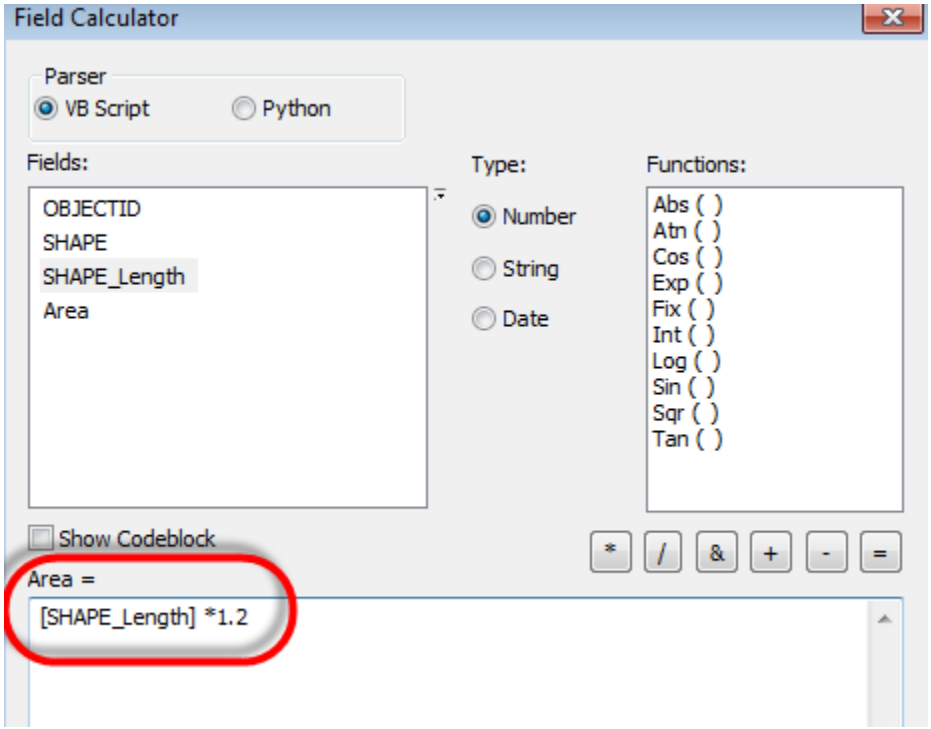
   - From the Table Options drop-down menu  in the attribute table view, select Add Field.

   - Name the field **Area**. Change the type to Double and click OK.

   - What's a double anyway? A double shot of espresso?



- To calculate area in square meters, simply right-click on the Area field and create the following expression and click OK. We're assuming that the average width of the trail is 1.2 meters. Don't mind the warning message…you know what you're doing.



4. What's the total area in square meters_____?

5. What if we wanted to know how much asphalt we need to repave the trails to a depth of 10 inches (0.254 meters), how much asphalt would we need then_____?

SECTION 3 – Parking Lot Team Project

I hope you listened to your instructor and saved each island and parking lot as a separate track and named it accordingly. Spending a little time in the field to annotate your tracks means less time in the office managing the data.

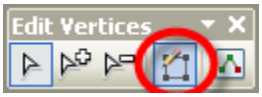
TASK 1: Clean-up the Data if Necessary

1. Start an editing session and clean-up any vertices that seem out of place.

   - Start an editing session by selecting the drop-down arrow on the **Editor Toolbar** and select **Start Editing**.
   - Click on the Edit Tool  on the Editor Toolbar.
   - Zoom into  the area you will be working in. Use can use the scroll wheel on your mouse to do this as well. Try it!
   - Using the **Edit Tool**  , double click on the line that you want to edit to show its vertices (green boxes).

   - Place your mouse over the vertex until it becomes a box surrounded by arrows. Left click and drag the vertex to the desired location.

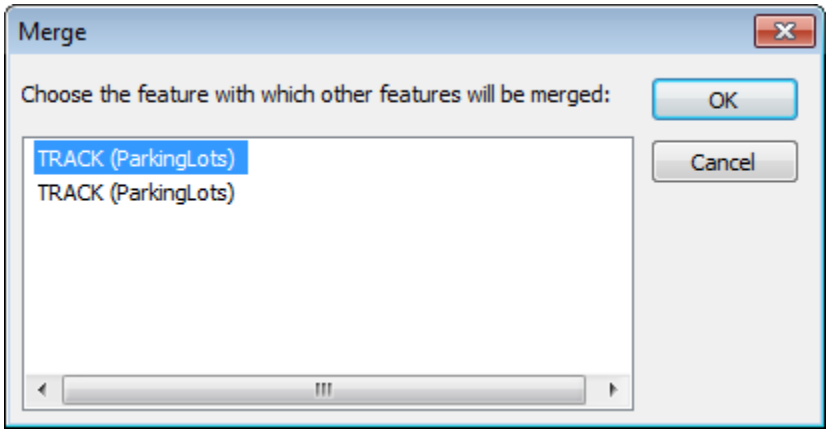
- Click on the **Finish Sketch** icon on the floating **Edit Vertices** toolbar or anywhere on the map to accept your changes.



- If you make a mistake, use the undo button on the **Standard** toolbar.
- To insert a vertex, click on the Insert Vertex tool on the **Edit Verticies** toolbar.
- To delete a vertex, click on the Delete Vertex tool on the **Edit Verticies** toolbar.

2. If you have polygons that are overlapping or bordering and should be one, here are the steps to make it all better.

- Select both polygons using the editor arrow and the Shift Key.
- Click Merge from the Editor Toolbar and click OK.



TASK 2: Erase the Islands

Erase the islands? Has the man lost it? Perhaps, but what we're referring to here is a tool called Erase that removes inner overlapping polygons and makes donut holes in the larger main polygon. The result is a clean polygon ripe for area calculation.

1. Next, use the Erase Tool to make donut holes in your Parking Lot layer.

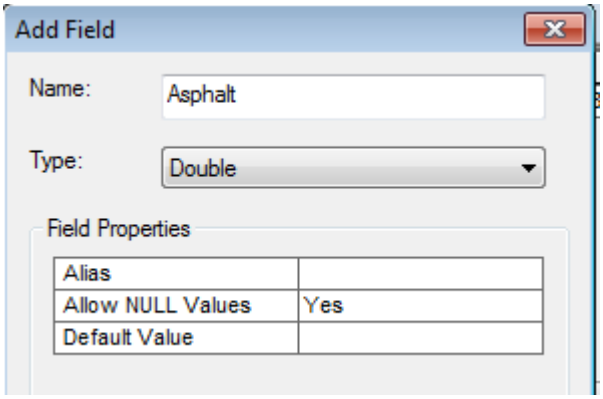
    - Open ArcToolbox on the side bar and browse to Analyst Tools > Overlay to find the Erase tool.
    - Your Input feature should be the Parking lots. The Erase feature will be the islands.
    - Save the final results as a feature class in the NCTC_2 geodatabase. Name the layer Parking_Lots_Final

TASK 3: Calculate How Much Material is Needed

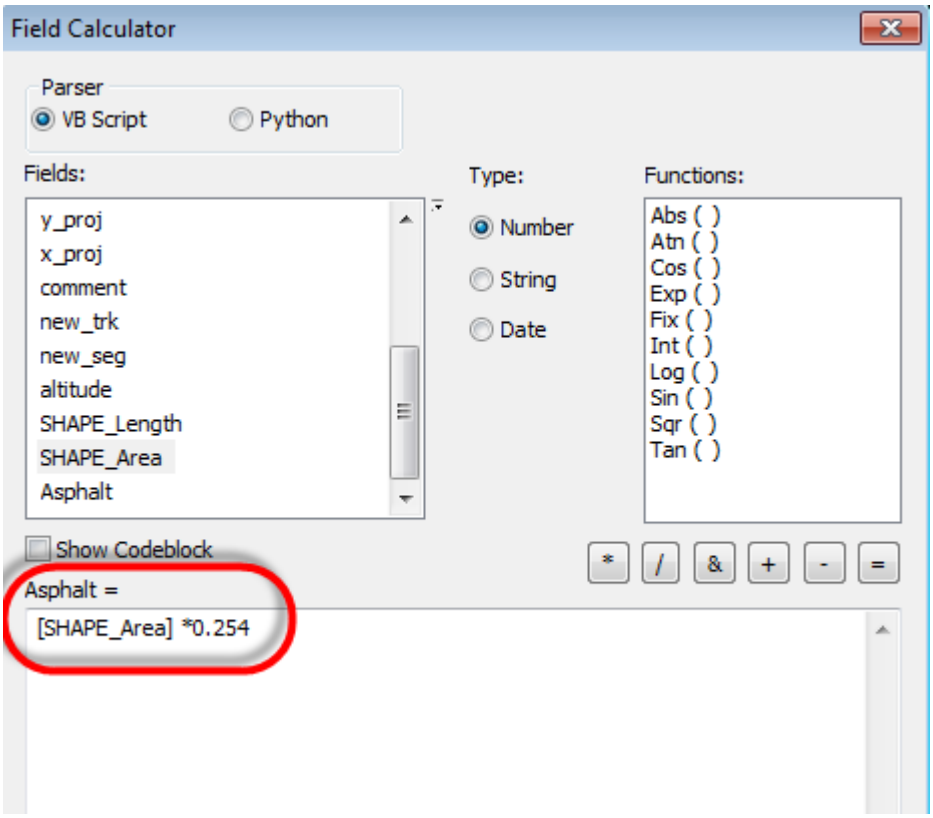
Given that the new pavement will be at a depth of 10 inches (0.254 meters), how much asphalt will be needed to repave the parking lots?

1. We first need to add a new field first then run the field calculator.

    - Right-click on the Parking_Lots_Final laye in the TOC to open the attribute table.
    - From the Table Options drop-down menu  in the attribute table view, select Add Field.
    - Name the field **Asphalt**. Change the type to Double and click OK.



- To calculate area in square meters, simply right-click on the Asphalt field and create the following expression and click OK. Don't mind the warning message…just go for it!



2. How much asphalt would we need to repave the parking lots_____?

SECTION 5 - Add GPS Project Summary to the Metadata

This is a really quick way to add detailed metadata to your GIS layer. Most of us simply do not have the time to sit down and fill-out all the mandatory 11 sections of metadata. So, for practical purposes, I highly recommend that you add the GPS project summary to the description field. The GPS project summary contains plenty of information for someone else to evaluate the data quality, and that is essentially the main reason for metadata.

1. Launch ArcCatalog from the desktop.

2. To add metadata, simply highlight your **Trails** or **Parking_Lots_Final** layer, select the **Description** tab and select the **Edit** tool Edit in the Items Description window.

3. Click **Item Descriptions** in the Overview section and scroll down to Descriptions.

4. Open Windows Explorer and copy the text from the **Infrastructure_Project_Summary.docx** file in the Field_Project folder and paste in the **Items Descriptions** field.

5. Click **Save**. That's it! As long as you have a GPS project summary you can create quick and easy metadata.