ECO GUIDE TO
Unstratified Samples

What Is an Unstratified Sampled?

If you have decided to conduct a **sample inventory**, you will be collecting data for plots located throughout your study area. In this type of project, you can choose to stratify or subdivide your study area into smaller units that can help clarify differences across the study area. For example, you might stratify your study area by land use, neighborhood, or political boundaries so that you can compare urban forest effects in different strata.

With an **unstratified sample**, you have chosen not to subdivide the study area and your Eco results will be estimated for the entire study area only. This is a simpler method and offers the advantage of true randomness. However, the decision to stratify should ultimately be based on your current and future project objectives and available resources.

> **Tip**
>
> The directions in this guide assume that you have already designed and created your Eco project as described in the **User's Manual**. See the **User's Manual** for help if you have not completed these steps.

Unstratified Sample Methods

There are several common sample creation methods that you can use when you create your sample. In this guide we will describe the three methods that are included in the Eco application. The following methods are described for unstratified sample projects in which you create a sample of plots by randomly placing them across the study area:

- **Load from File** – Create a sample of plots and then import the plot list into Eco. This section includes directions for creating your plot sample in ESRI's ArcGIS, formatting the necessary files for Eco, and importing the files using the **Load from File** function.

- **via Google Maps** – Create a sample of plots directly in the Eco application using the random plots generator in the **via Google Maps** function.

- **User Defined** – Manually define the plot size and number of plots in your study area using the **User Defined** function.

There are many ways to create your plot sample. Your decision should be based on the objectives of your study and the resources available to create the layout. You can use any method you like to create your sample, including paper maps and pencil, as long as it follows random sampling conventions.

> **Tip**
>
> Some Eco users collaborate with local universities or government agencies for assistance to create random plot layouts for their projects.

Load from File

i-Tree Eco offers a two-step method for defining your sample plots outside of the application, and then importing the plot data into Eco. First, create your random sample using ArcGIS as described below. Second, import your file list using the **Load from File** function in the Eco application.

Creating a Random Sample in ArcGIS

These instructions will help users of all skill levels create a random sample of i-Tree Eco plot centers, plot areas, and the associated i-Tree Eco-required data files for their study area. The steps below are based on ESRI ArcGIS software with the Spatial Analyst extension. However, the instructions are generic and can be modified to suit different versions of ArcGIS as well as other GIS software in terms of basic operations.

These instructions involve three basic steps:

1. Prepare project area data.
2. Generate sample plots.
3. Create Eco-ready output.

When finished, you will have created the following:

- Area-of-interest (AOI) map layer composed of a single (or multi-part) polygon.
- Random sample plot centers point map layer with Eco-required fields added and populated.
- Sample plot areas polygon map layer.

- Eco-ready Strata Area text file.
- Eco-ready Plot List text file.
- Eco-ready Projection prj file.

Tips

- The Spatial Analyst extension for ArcGIS is required.
- Field names and types are important.
- Obtain projection system and map unit information from the map data provider first.
- All map data must have valid projection information for proper alignment.
- AOI map data must be in a projection system that uses feet or meters – <u>not</u> degrees.
- Final Eco-required map units will be metric.
- AOI examples are polygons, e.g., city boundary, park areas, or management zones.
- ESRI shapefiles are easiest to use.
- "Pin" open ArcToolbox when starting – pushpin icon, upper right of ArcToolbox panel.
- Practice good file management: Create folders to hold copies of original data, folders to hold output, employ logical file naming, etc.
- ArcGIS should add the geoprocessed map layers to the view automatically. If not, use the File > Add Data > Add Data… menu to load the layers.

STEP 1: Prepare project area data

Overview
- Obtain a GIS map layer representing the area-of-interest (AOI) polygon(s) for your project area.
- Launch the ArcMap application of ArcGIS.
- Load the AOI map layer into the data view.
- Define the projection/coordinate system of the AOI if needed.
- Reproject the AOI to a system using feet or meters if needed.
- Dissolve the AOI into a single polygon (a single, multi-part polygon if more than one polygon).
- Add Eco-required fields and calculate appropriate values for them.

Detailed instructions

1   Obtain an area-of-interest (AOI) polygon from your GIS Department or an online resource. Several options can be found here: www.esri.com/data/free-data.

2   Launch ArcMap. Save your project with an appropriate name at a new location via the **File** > **Save As** menu. Save periodically while working to avoid data loss.

3 Use the **File > Add Data > Add Data…** menu to browse to and load the AOI polygon map layer to the current view.

   a If your data are properly projected, ArcGIS should handle projection differences between the AOI and subsequent map layers on the fly.

   b If your data lack projection information, an "Unknown Spatial Reference" message may appear. Click **OK** to move past it and use ArcToolbox to define the projection of the AOI map layer according to your data provider's specifications.

4 Navigate to **ArcToolbox > Data Management Tools > Projections and Transformations > Define Projection** and complete the Define Projection form as follows:

   a For **Input Dataset**, choose the AOI map layer from the drop-down list.

   b For **Coordinate System**, click the **Properties** button to the right.

   c In the **Spatial Reference Properties** window that appears, click **Select** and choose the coordinate system indicated by your data provider.

5 If necessary, use ArcToolbox to reproject your AOI map layer to a system using feet or meters, ideally selecting a projection system already in use by your organization or a commonly used system, e.g., State Plane or UTM in the United States.

6 Navigate to ArcToolbox > Data Management Tools > Projections and Transformations > Feature > Project and complete the Project form as follows:

   a For **Input Dataset**, select the AOI map layer from the drop-down menu.

   b **Input Coordinate System** should be grayed out based on your work in the previous step or per your data provider.

   c For **Output Dataset or Feature Class**, use the **Browse** button to the right and navigate to a suitable location to save the output file and give it a name.

   d For **Output Coordinate System**, click the **Properties** button to the right.

   e In the **Spatial Reference Properties** window that appears, click the **Select** button and navigate to the proper coordinate system.

   f For **Geographic Transformation**, select the first choice in the drop-down list if prompted with an "Undefined Geographic Transformation" message.

    g   Click **OK** when you've completed all the boxes.

7   If your AOI has more than one polygon, you must use ArcToolbox to dissolve them. (If not, skip to #8 below.)

    a   Navigate to **ArcToolbox > Data Management Tools > Generalization > Dissolve** and complete the Dissolve form as follows:

    b   For **Input Features**, select the projected AOI map layer from the list.

    c   For **Output Feature Class**, use the **Browse** button to navigate to a suitable location and give the file a name.

    d   For **Dissolve Field**, check the data field attribute value that unifies the AOI. (For example, a "Name" field containing the city name of an AOI, even across physically separate city sections.) You may need to peruse the layer's attribute table to find this.

    e   Leave the **Statistics** field blank.

    f   Ensure the **Create Multipart Features** box is checked.

    g   Click **OK** to finish.

8   Right-click the new dissolved **AOI polygon layer, Open Attribute Table** and verify that there is now a single, multipart polygon present.

9   Use ArcToolbox to add Eco-required fields to the projected, dissolved AOI map layer:

    a   Navigate to **ArcToolbox > Data Management Tools > Fields > Add Field** and complete the Add Field form as follows:

    b   Under **Input Table**, select the dissolved AOI map layer from the dropdown list.

    c   For **Field Name**, enter "**Strat_ID**"

    d   For **Field Type**, select **LONG** from the drop-down list.

    e   Skip the following fields:
- Field Precision
- Field Scale
- Field Length
- Field Alias
- Field is Nullable

- Field is Required
- Field Domain

    f   Click **OK**.

10 Repeat the steps above as follows for these additional fields:

    a   For **Field Name**, enter "**Strat_Area**" and select **DOUBLE** from the **Field Type** drop-down list.

    b   For **Field Name**, enter "**Strata**" and select **TEXT** from the **Field Type** drop-down list.

11 Use the attribute table Field Calculator to populate values for the Eco-specific fields added to the projected, dissolved AOI map layer:

    a   Right-click the projected, dissolved AOI map layer and select **Open Attribute Table**.

    b   Right-click the **Strat_ID** field column heading and select **Field Calculator**.

    c   In the large text entry box below **Strat_ID =**, enter: **1**.

    d   Click **OK**.

    e   Repeat for the **Strata** field.

    f   In the large text entry box below **Strata =**, enter: "**Single Strata**" (**Note:** In this case, include the quotes!)

    g   Click **OK**.

    h   Right-click the **Strat_Area** field column heading and select **Calculate Geometry**.

    i   For Property, choose **Select Area**. If this is not available, your AOI map layer is not in a projection system using feet or meters; see Steps 4 and 5.

    j   For **Coordinate System**, choose **Use coordinate system of the data source**.

    k   For **Units**, select **Hectares [ha]**.

    l   Close the Attribute Table when finished.

Results

An area-of-interest (AOI) single polygon map layer with Eco-required fields added and populated. The AOI polygon map layer is now ready to be used for plot generation.

STEP 2: Generate sample plots

Overview
- Run the Create Random Points tool from ArcToolbox for the AOI.
- Add Eco-required fields to the random plots data.
- Calculate field values for the random plots data.
- Buffer the random plots point data to form plot areas.

Detailed instructions

Use the Create Random Points tool in ArcToolbox to generate the desired number of plots for the projected, dissolved AOI.

1   Navigate to **ArcToolbox > Data Management Tools > Feature Class > Create Random Points**.

2   Complete the **Create Random Points** form:

    a   For **Output Location**, browse to your working folder, single-click to select it, and click **Add**.

    b   For **Output Point Feature Class**, type in an appropriate name with a .shp extension.

    c   For **Constraining Feature Class**, select your projected, dissolved AOI polygon map layer.

    d   For **Number of Points** [value or field], enter the desired number of sample plots for this selected land cover.

    e   Skip the remaining inputs.

    f   Click **OK**.

Use ArcToolbox to add Eco-required fields to the newly created sample plots point map layer.

1   Navigate to **ArcToolbox > Data Management Tools > Fields > Add Field**.

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2   Complete the **Add Field** form:

   a   For **Input Table**, select the newly created sample plots point map layer from the drop-down list.

   b   For **Field Name**, enter: "**ID**"

   c   For **Field Type,** select **LONG** from the drop-down list.

   d   Skip the following fields:
   - Field Precision
   - Field Scale
   - Field Length
   - Field Alias
   - Field is Nullable
   - Field is Required
   - Field Domain

   e   Click **OK**.

3   Repeat the steps above as follows for these additional fields:

   a   For **Field Name**, enter "**LCCode**" and select **SHORT** from the **Field Type** drop-down list.

   b   For **Field Name**, enter "**X_Coord**" and select **DOUBLE** from the **Field Type** drop-down list.

   c   For **Field Name**, enter "**Y_Coord**" and select **DOUBLE** from the **Field Type** drop-down list.

Use the attribute table Field Calculator to populate values for the Eco-specific fields added to the sample plots point map layer in the step above.

1   Right-click the sample plots point map layer and select **Open Attribute Table**.

2   Right-click the **ID** field column heading and select **Field Calculator**.

   a   In the large text entry box below **ID =**, enter: "**[FID]+1**"

   b   Click **OK**.

3   Repeat step 2 for the **LCCode** field.

      a   In the large text entry box below **LCCode =**, enter: **1**

4 Right-click the **X_Coord** field column heading and select **Calculate Geometry**.

      a   For **Property**, select **X Coordinate of Point**.

      b   For **Coordinate System**, choose **Use coordinate system of the data source**.

      c   For **Units**, select **Meters [m]**.

      d   Click **OK**.

5 Right-click the **Y_Coord** field column heading and select **Calculate Geometry**.

      a   For **Property**, select **Y Coordinate of Point**.

      b   For **Coordinate System** choose **Use coordinate system of the data source**.

      c   For **Units**, select **Meters [m]**.

      d   Click **OK**.

6 To verify the attributes have been correctly modified in the sample plots point map layer, right-click the sample plots point map layer in the map layers list, and choose **Open Attribute Table**.

      a   Scan through the fields and their values to verify they are correct.

Optional: Use ArcToolbox to buffer the sample plots point map layer. This process creates the plot of your desired survey size around the plot centers and can be used to make field data collection plot maps.

1 Navigate to **ArcToolbox > Analysis Tools > Proximity > Buffer**.

2 Complete the **Buffer** form:

      a   Under **Input Features**, select the sample plots point map layer from the drop-down list.

      b   For **Output Feature Class,** use the **Browse** button to navigate to a suitable location and choose a file name for the resulting map layer.

      c   For **Distance**, in the **Linear Unit** box, enter the distance value from the list below, based on your desired plot size. (The distance is the radius of the plot.)

Feet:

For 1/5-acre plots, enter: **52.66**
For 1/10-acre plots, enter: **37.24**
For 1/20-acre plots, enter: **26.33**
For 1/100-acre plots, enter: **11.78**

Meters:

For 1/5-hectare plots, enter: **25.23**
For 1/10-hectare plots, enter: **17.84**
For 1/20-hectare plots, enter: **12.62**
For 1/100-hectare plots, enter: **5.64**

   d   Select Feet or Meters as appropriate from the units drop-down list.

   e   Skip the following entries:
  - Side Type
  - End Type
  - Dissolve Type
  - Dissolve Field(s)

   f   Click **OK**.

3   The buffered sample points layer is added to the map view automatically; zoom in to examine individual plot areas. (**<u>Note</u>:** Choose an appropriate equal-area projection system in the layers data view properties if your plot areas appear not to be circular.)

Results

Sample plots point map layer.
  - User-defined number of plots randomly spread throughout the AOI.
  - Plot points assigned with land cover categories.
  - Eco-required fields added and populated.

Sample plot areas polygon map layer (optional).

STEP 3: Create Eco-ready output

Overview
  - Export select fields from the Plot attribute table to a text file.
  - Export select fields from the Strata polygons attribute table to a text file.
  - Copy and rename the AOI projection file.

Detailed instructions

1 From the **Selection** menu, choose **Clear Selected Features**, if available, to unselect all features.

2 Right-click the spatially joined sample plot centers *point* map layer in the map layers list and select **Open Attribute Table**.

    a Right-click the **FID** field and select **Turn Field Off**.

    b Repeat for all but the **ID**, **LCCode**, **X_Coord**, and **Y_Coord** fields (added in Sample Plot Generation above).

    c Under the upper left **Table Options** drop-down button, select **Export**.

    d Browse to a folder where you wish to save the output file.

    e For **Save the file as** type, select **Text File**.

    f Name the export appropriately, e.g., "myEcoPlots_mmyyyy.txt."

    g Click **No** when asked whether to add the new table to the current map.

3 Open the text file in a simple editor, e.g., Windows Notepad (avoid using word processing software due to formatting issues).

    a Use the **Search and Replace** function to replace each comma with a space.

    b Save the file.

    c Delete the first line containing these field names: "ID," "LCCode," "X_ Coord," "Y_Coord."

    d Copy and paste these two lines at the top of the file:
      $ U4PLLS! 1.3 20040728 1549
      1

    e A properly formatted file will look like this:
      $U4PLLS! 1.3 20040728 1549
      1
      1 1 1199094.600650 2095374.121430
      2 1 1202999.760510 2094522.116280
      3 1 1207382.288000 2096877.180300
      4 1 1198150.473980 2101783.086320

...

4   Right-click the dissolved land cover polygon layer in the map layers list and select **Open Attribute Table**.

    a   Right-click the **FID** field and select **Turn Field Off**.

    b   Repeat for all but the **Strat_ID**, **Strat_Area**, and **Strata** fields (added in Strata Preparation above).

    c   Under the **Table Options** drop-down button, select **Export**.

    d   Browse to a folder where you wish to save the output file and save as a text file.

    e   Name the export appropriately, e.g., "myEcoStrata_mmyyyy.txt."

    f   Click **No** when asked whether to add the new table to the current map.

5   Open the text file in a simple editor (avoid using word processing software).

    a   Use the **Search and Replace** function to replace each comma with a space.

    b   Save the file.

    c   Delete the first line containing these field names: "Strat_ID," "Strat_ Area," "Strata"

    d   Copy and paste these two lines at the top of the file:
        $U4STAR! 1.3 20040728 1549
        1

    e   A properly formatted file will look like this:
        $U4STAR! 1.3 20040728 1549
        1
        1 15138.785733 "Developed"
        2 3187.141038 "Open"
        3 217.131072 "Other"
        ...

6   Make a copy of the .prj file associated with your dissolved land cover polygons layer.

    a   In Windows Explorer, browse to your working folder and copy/paste the .prj file associated with this shapefile.

      b   Right-click the copied file, and Rename it appropriately, e.g., "myEcoProjection_mmddyyyy.prj."

Results

Three Eco-ready files:
- Plot List File (txt format).
- Strata File (txt format).
- GIS Projection File (prj format automatically created in the Define Projection/Reprojection steps above as part of the **STEP 1: Prepare project area data** section).

Importing Plot Files in i-Tree Eco

In the **Project Configuration** tab of the Eco desktop application, click on the **Load from File** function of the **Define Plots** group.

1   Click on the **Browse** button next to the **Plot List File** box.

2   Navigate to the plot list file that you previously created and click **Open**. This file must be in txt format.

3   Click on the **Browse** button next to the **Strata File** box.

4   Navigate to the strata file that you previously created and click **Open**. This file must be in txt format.

5   Click on the **Browse** button next to the **GIS Projection File** box.

6   Navigate to the GIS projection file that you previously created and click **Open**. This file must be in prj format.

7   Click **Import**.

via Google Maps

i-Tree Eco offers a random plot generator that allows you to create your sample right in the application itself. The plot generator works with Google Maps and utilizes study area boundaries that can be drawn by the user or supplied from an ESRI ArcGIS shapefile. This method can be used whether you have decided to stratify your sample or not. However, in the Google Maps Plot Generator, plots are distributed randomly and cannot be distributed on a fixed grid or randomized grid.

In the **Project Configuration** tab of the Eco desktop application, click on the **via Google Maps** function of the **Define Plots** group.

To prepare an unstratified plot layout, you will be choosing one of the "Simple random" options. For this option, you must first define the boundaries of your study area either by providing a GIS shapefile of the boundary or drawing the boundary in Google Maps.

Simple Random (Shapefile Boundary)

Use this option if you already have a GIS shapefile boundary defined for your area of interest. All of your plots will be randomly distributed within that boundary. Simple random sampling will generate plot locations as random sets of latitude and longitude coordinates within your boundary. This is the most basic type of sampling and is appropriate for most projects focused on summaries for your entire area of interest.

1   Have an ESRI ArcGIS shapefile of the boundary of your project area ready. You must have the shp, dbf, and shx files associated with this boundary and the shapefile <u>must</u> be in geographic projection (latitude/longitude).

2   Select **Simple random (shapefile boundary)** next to **Options**.

3   Click on the **Browse** buttons next to each of the shapefiles boxes in turn.

4   For each shapefile box, navigate to the GIS shapefile that you have and click **Open**.

   (**Note:** The shapefiles that you enter must be in shp, dbf, and shx formats. Be sure to select the appropriate format for each entry.)

5   Click on the **Proceed to random plot generation** button.

6   Confirm that you want to create a simple random sample (i.e., unstratified plot layout) using a shapefile boundary by clicking **OK** in the message that pops up.

7   Indicate how large your sample plots should be by leaving the "0.1 acres" or "0.0407 hectares" (standard plot size) selected or entering a custom plot size or radius in the box provided.

   (**Note:** If you are entering a custom plot size, be sure to look at the units displayed and enter a value that corresponds to those units.)

8   Indicate how many sample plots to create by entering a number of plots or percent of the project area that you would like to sample in the boxes provided.

(**Note:** The project area based on your study area boundary appears below the Google Maps display.)

9   Click on the **Generate random sample plots** button.

10 Click **OK**.

Simple Random (User Drawn Boundary)

Use this option if you do not have a GIS shapefile defining the boundary of your area of interest. You will draw your boundary using Google Maps. All of your plots will be randomly distributed within that boundary. Simple random sampling will generate plot locations as random sets of latitude and longitude coordinates within your boundary. This is the most basic type of sampling and is appropriate for most projects focused on summaries for your entire area of interest.

1   Select the **Simple random (user drawn boundary)** next to **Options**.

2   Click on the **Proceed to random plot generation** button.

3   Enter the approximate location of your study area (e.g., city and state) in the space provided and click **Go**. The map in the Google Map display should zoom to that location.

4   Use the navigation and zoom tools on the left-hand side of the map display to adjust the view of your study area.

5   Use the **Map** and **Satellite** buttons at the top of the map display to toggle those displays on and off.

6   To draw your boundary, click on the **Draw polygon** tool located above the upper left-hand corner of the map display.

     a   While this tool is active, click on the map to start drawing your boundary.

     b   Click at each location where you would like to add a point to your boundary.

     c   Double-click to finish the drawing.

7   To delete a boundary that you have drawn, click on the polygon to select it and then right-click on the polygon. Click on the **X** button that appears.

8   When you have a boundary that you are satisfied with, click on the **Done and Continue** button.

9   Indicate how large your sample plots should be by leaving the "0.1 acres" or "0.0407 hectares" (standard plot size) selected or entering a custom plot size or radius in the box provided.

(**Note:** If you are entering a custom plot size, be sure to look at the units displayed and enter a value that corresponds to those units.)

10 Indicate how many sample plots to create by entering a number of plots or percent of the project area that you would like to sample in the boxes provided.

(**Note:** The project area based on your study area boundary is displayed below the Google Maps display.)

11 Click on the **Generate random sample plots** button.

12 Click **OK**.

User Defined

i-Tree Eco offers a method for defining your sample plots manually in the application. In the **Project Configuration** tab of the Eco desktop application, click on the **User Defined** function of the **Define Plots** group.

1   Enter the size of your sample plots in the box provided above the table.

(**Note:** Make note of the units – i.e., acres or hectares – shown next to the **New Plot Area** box and be sure that the plot size you enter corresponds with the units listed.)

2   Enter the number of plots to be added to your study area in the column labeled "Plots to Add."

(**Note:** The default stratum for new Eco projects is urban. Users may change the "Strata Description," "Strata Abbreviation," and "Area" in both the **User Defined** and **Project & Strata Area** functions in the **Project Configuration** tab. For an **unstratified sample**, only one stratum should be defined and it should encompass the entire study area.)

3   When you are satisfied with your strata and plots, click **OK** in the top right-hand corner of the action panel. This will save the edits that you have made to the table.

4   Click **Cancel** if you decide to revert to all of the previous values, whether default values or those that you had previously entered manually.

Adding Plots

When you plan your i-Tree Eco project, one of the decisions that you make early on is how many plots should be included in your plot sample. While this decision should be based on your project goals, we do recommend that you add an extra 5-10% to your final number of plots. These extra plots can serve as replacements where another plot is inaccessible.

For example, let's say that you have started a new project in Eco and defined your plots for your **unstratified sample** using one of the methods outlined above (**Load from File**, **via Google Maps**, or **User Defined**). Despite the best planning efforts, you may find yourself in a position where you need to add more plots to your sample. The simplest way to do this is using the **User Defined** function as described above.