Southeast Coast Network

National Park Service
Inventory & Monitoring Program

Standard Operating Procedure (SOP) #1.2.1

Generating Spatially-Balanced Sampling Locations for Coastal Assessments using ArcGIS 10

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Summary

This Standard Operating Procedure (SOP) outlines the procedure used to generate spatially-balanced sampling points using ArcGIS 10. The ArcGIS tool uses a Reversed Randomized Quadrant-Recursive Raster (RRQRR) algorithm to generate sampling locations (Theobald et al. 2007), when the incorporation of pre-existing sampling locations is not necessary. This method produces sets of sampling locations that are compatible with those used by the USEPA Coastal Assessment Program (Virginia Engle, USEPA, pers. comm.). This SOP assumes the user has an intermediate skill level with ArcGIS.

Revision Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Required Materials

- ArcGIS 10
    - Spatial Analyst License

Procedure

**NOTE: Ensure all files used in this process are projected in UTM.

Setting Geoprocessing Environment

1. Open ArcMap.
2. Adjust the Geoprocessing environment with the "Geoprocessing" dropdown menu > Environments. Set the appropriate workspace.(Figure 1).

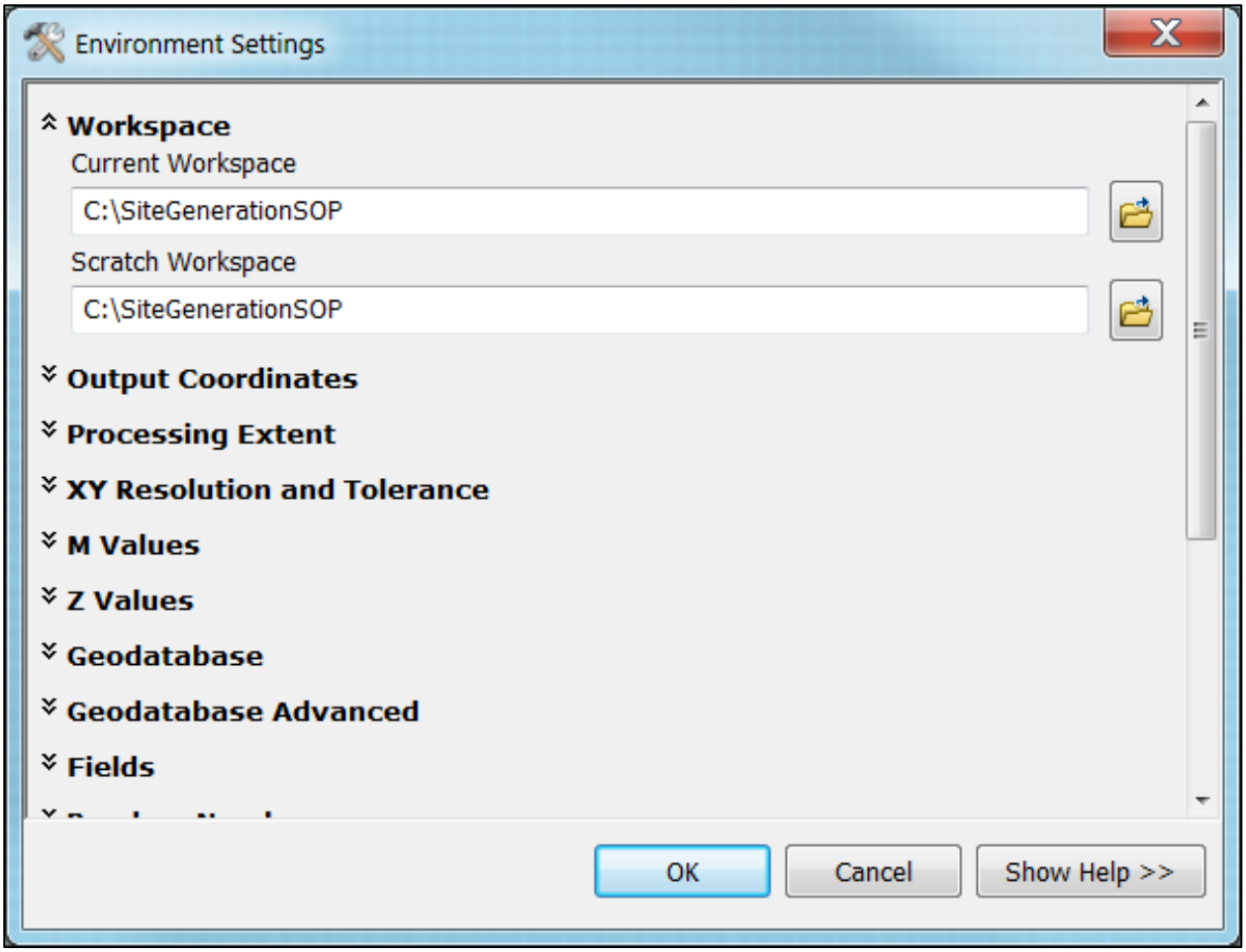

Figure 1. Geoprocessing environments options.

Create a Half Hectare Raster

If available, use the existing dem_05ha grid. For all of the SECN parks with 2012 boundaries, a dem_05ha grid has been created and this section should be skipped. If no raster exists for the park, or the boundaries have been updated, use the following procedure.

1. Add the park boundary to the project.
2. Right click the park boundary layer and click "Zoom to Layer".
3. Open the "Create Random Raster" Tool (ArcToolbox > Spatial Analyst Tools > Raster Creation > Create Random Raster).
4. Populate the tool fields as follows (Figure 2):
    a. Output raster: Name your file (will automatically be saved to the Workspace folder specified in geoprocessing environments).
    b. Output cell size: 70.7106781 (cell size for a half hectare).
    c. Output extent: Leave as the default. If a dem_05ha grid raster exists, then use that shapefile as the output extent.

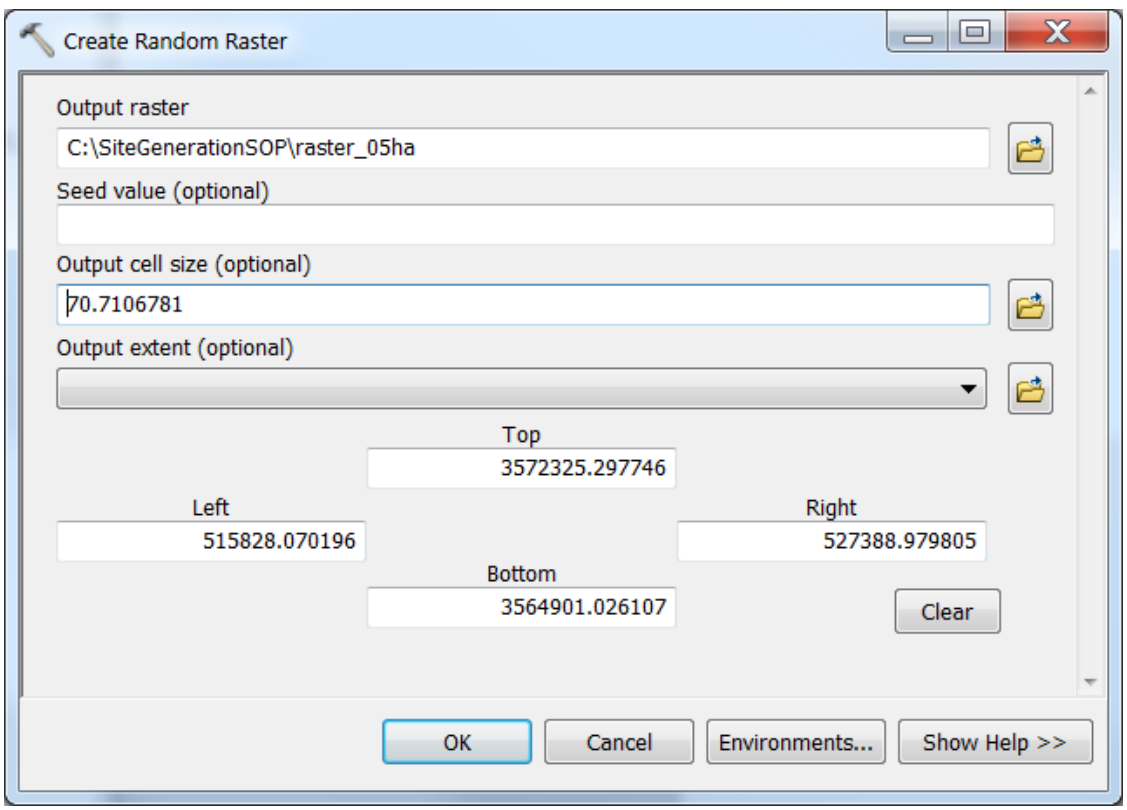

Figure 2. Create Random Raster options.

5. Click "Environments"
    a. In the "Processing Extent" drop down, change "Extent" to "Same as Display".

   b. If a dem05_ha raster exists, but was not created from the current boundary, it should be used as the “Snap Raster”.

6. Click “OK”.

Create a Half Hectare Shapefile

1. Add the dem_05ha raster created in the previous section and the park boundary shapefile, if not already in the project from the previous section.
2. Adjust Geoprocessing environment with the “Geoprocessing” dropdown menu > Environments. In the “Processing Extent” menu change the “Extent” to “Same as layer dem05ha”.
3. Open the “Create Fishnet” Tool (ArcToolbox > Data Management Tools > Feature Class > Create Fishnet).
4. Populate the tool fields as follows: (Figure 3).
   a. Output feature class: grid_temp (this file can be discarded at the end)
   b. Template extent: park boundary
   c. Cell Size Width: 70.7106781
   d. Cell Size Height: 70.7106781
   e. Number of Rows: 0
   f. Number of Columns: 0
   g. Uncheck the “Create Label Points” box
   h. Geometry Type: Polygon

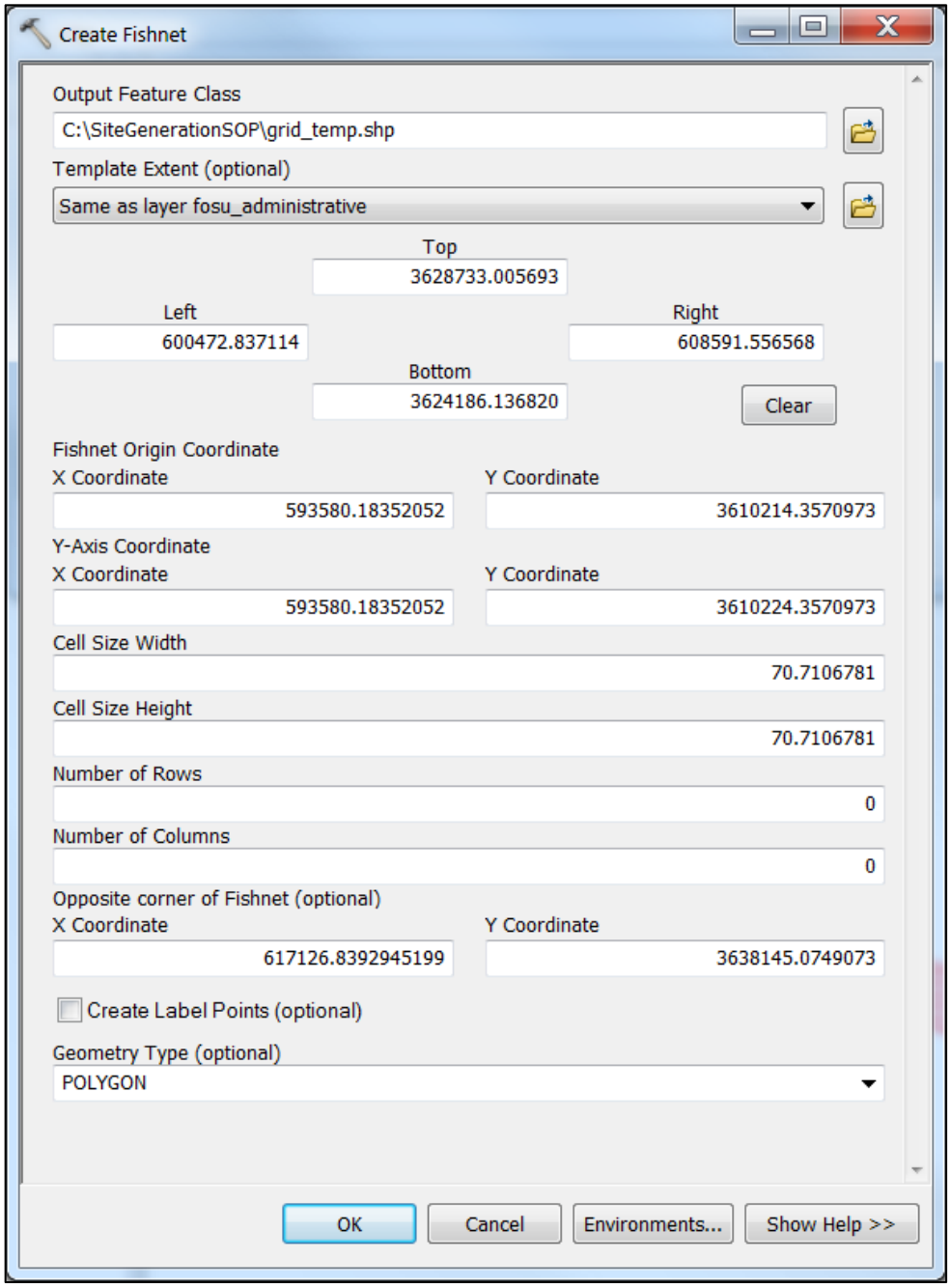

Figure 3. Create Fishnet options.

5. Click “OK”
6. The resulting polygon is added to the project and should align with the dem_05ha raster.
7. Open the “Clip” Tool (ArcToolbox > Analysis Tools > Extract > Clip)
8. Populate the tool fields as follows (Figure 4):
    a. Input Features: grid_temp

b. Clip Feature: park boundary shapefile

c. Output Feature Class: parkgrid_05ha.shp

d. Click OK.

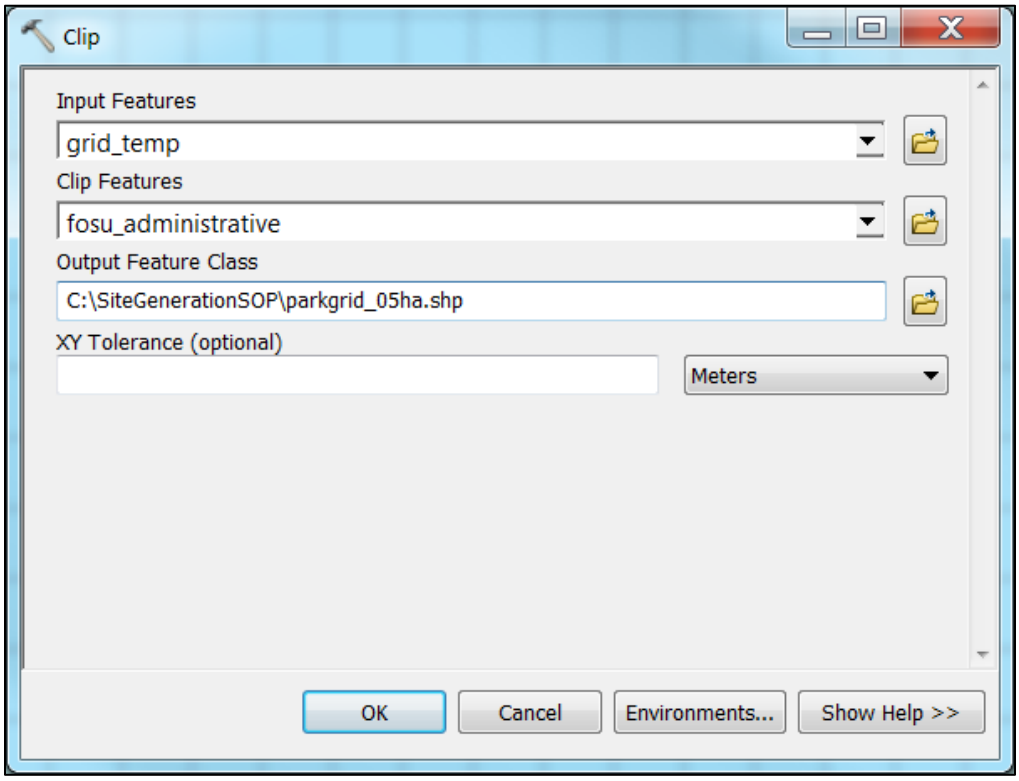

Figure 4. Clip options.

Create an Inclusion Probability Raster

1. Add parkgrid_05ha.shp and the raster file dem_05ha, created in the previous sections, to the project. These files delineate the sampling frame.
2. Convert parkgrid_05ha.shp to a raster (ArcToolbox > Conversion Tools > To Raster>Polygon to Raster).
3. Populate the tool fields as follows (Figure 5):
    a. Input field: parkgrid_05ha
    b. Output raster dataset: use default, as this file is an intermediate file and will be discarded
    c. Cell size: Same as dem_05ha raster or 70.7106781

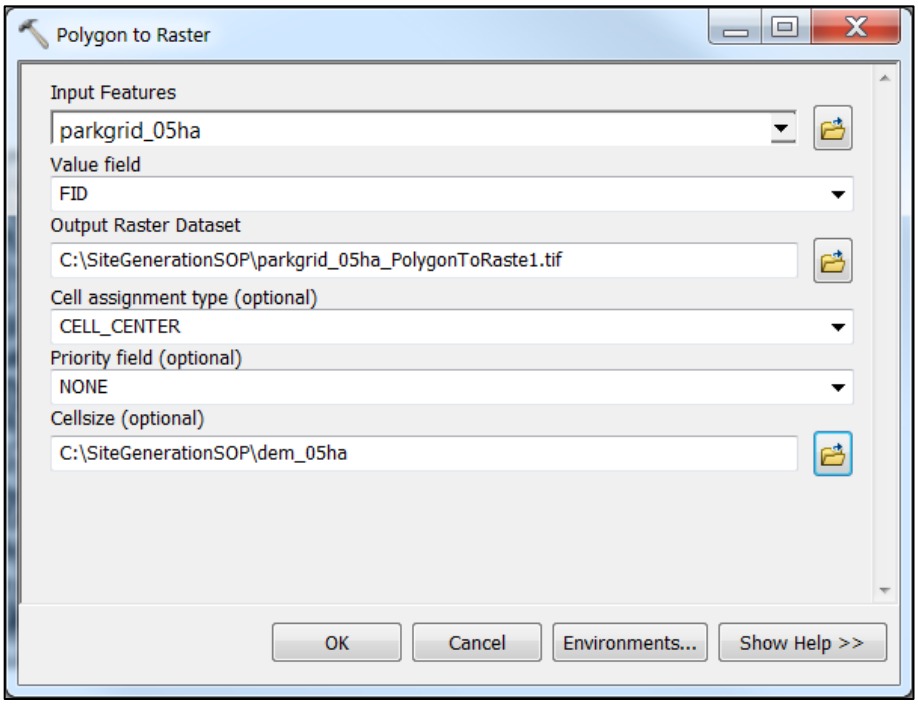

Figure 5. Feature to Raster options.

d. Click "Environments" (Figure 6).

   i. In the "Processing Extent" dropdown identify dem05ha as the Output Extent, and dem05ha as the Snap raster.

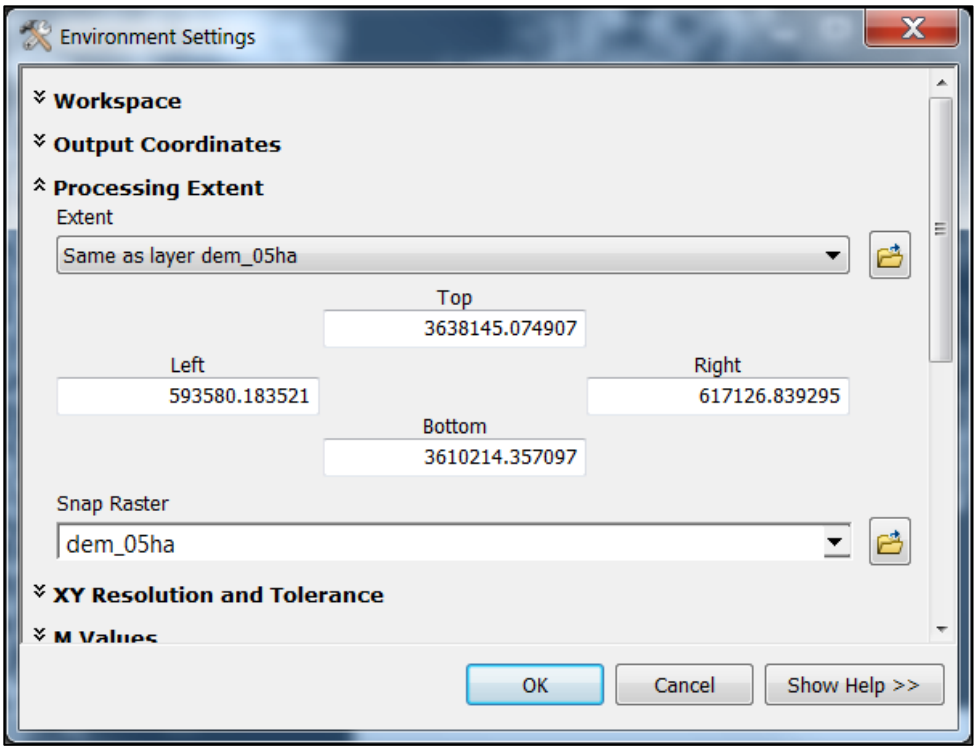

Figure 6. Environmental Settings in Feature to Raster options.

4. Click "OK"
5. The new raster file is added to the project view automatically. In this new raster file, the cell values must be edited to the target inclusion probability used for the sampling design (i.e., inclusion probability = 1).
6. Open the Raster Calculator (ArcToolbox > Spatial Analyst Tools > Map Algebra > Raster Calculator). Enter the expression: **"parkgrid_05_PolygonToRaste"*0+1** into the calculator (including quotes; see Figure 7).
   Note: "parkgrid_05_PolygonToRaste" is the shapefile created in step 2 and names are case sensitive. Change the output raster name to incprob1_4-digitparkcode (e.g., incprob1_FOMA), press OK (Figure 7).
7. The raster is automatically added to the project view. Ensure all values of this file are equal to one (i.e., inclusion probability of 100%). Because the inclusion probability of all of the raster cells are equal, the attribute table should only consist of one row.

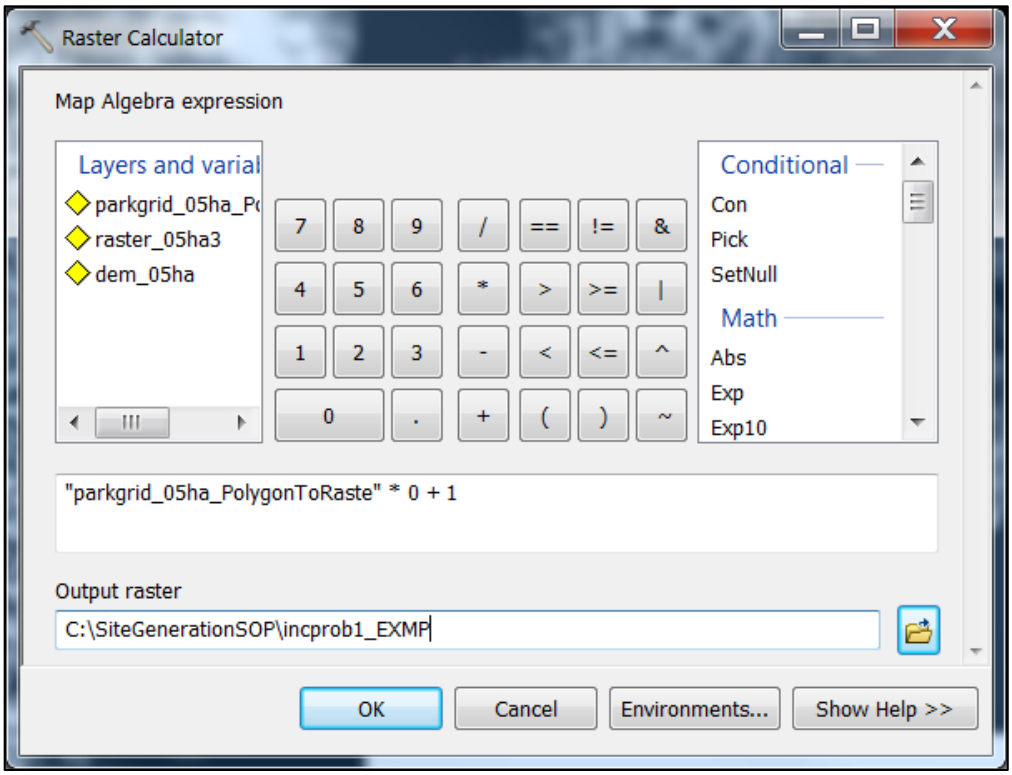

Figure 7. Raster Calculator settings.

Create Sampling Locations

1. Open the "Create Spatially Balance Points" Tool (ArcToolbox > Geostatistical Analyst Tools > Sampling Network Design > Create Spatially Balanced Points) (Figure 8).
2. Select incprob1_EXMP (created in the previous section) for the "Input inclusion probability raster".
3. Identify how many sites to select. This example uses 50.
4. Name the output file.
5. Click "OK".
6. The new points (i.e., sampling locations) are automatically added to the project view.

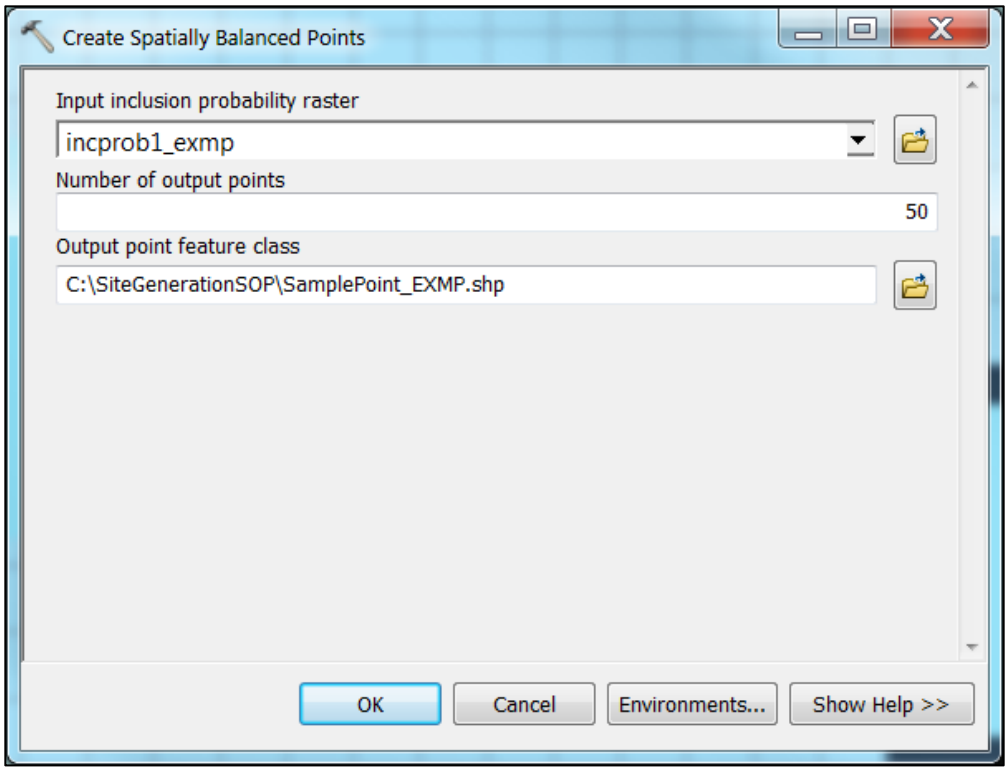

Figure 8. Create Spatially Balanced Points options.

Literature Cited

Theobald, D. M., D. Stevens, D. White, N. Urquhart, A. Olsen, J. Norman. 2007. Using GIS to generate spatially-balanced random survey designs for natural resource applications. Environmental Management 40(1):134-146.