Edge Crossing Characterization

These instructions enable you to determine how often an organism crosses an edge and includes calculations on the edge shape and types of landcover surrounding the edge crossing. This analysis can be applied to such ecology problems as bear movement with respect to cutblocks and related dispersal applications. Using ArcGIS 9.x (**ARCINFO 9.2**) software, a custom ModelBuilder tool, and HawthsTools (www.spatialecology.com) perform the following steps:

- Create paths from locations (HawthsTools)
- Add point location attributes to path segments
- Intersect paths with edge layer to identify path crossing points
- Generate random path segments from starting/end points related to original crossing points (ModelBuilder tool)
- Intersect random paths with edge layer to identify crossing points
- Optionally, merge path crossings with random crossings for all crossings
- Identify shape of edge by converting edge layer to vertices and apply POINTSTATS() function with npoints statistic, or convert to lines and apply LINESTATS() function with length statistic
- Identify landcover proportions by applying the FOCALMEAN(CON()) function on the landcover raster
- Intersect crossing points with the above raster layers

ORIGINAL DATA THEME

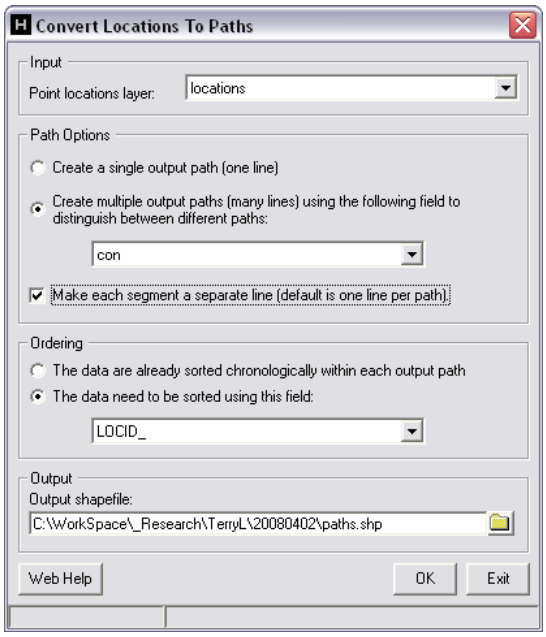
locations.shp	a point shapefile of observation locations containing an attribute for individual & season & year (this can be concatenated from other fields)
edge.shp	a polygon shapefile of habitat/nonhabitat (this example uses cutblocks from forest harvesting)
landcover	a raster grid of landcover classes

CREATED DATA THEMES

paths.shp	a polyline shapefile of segments connecting the point locations
paths_loc.shp	the same polyline path segments with original point location attributes incorporated in to the table
crossings.shp	a point shapefile identifying where path segments intersect with edges
edge_vertices.shp	a point shapefile representing the vertices along the edge layer
vcount	a raster grid representing the number of vertex points within a ‘buffer’ radius
pclass1, pclass2, pclass3, etc.	raster grids representing proportion of landcover class within a ‘buffer’ radius

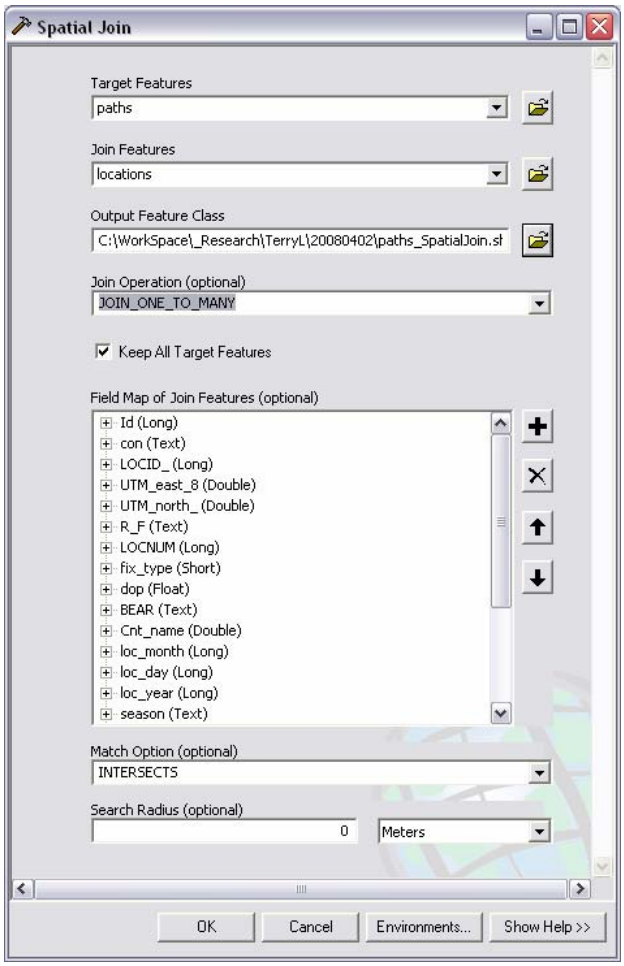
Create path segments with original point location attributes

1. Start a new empty map document
2. Enable extensions and show toolbars for Spatial Analyst and HawthsTools
3. ADD DATA: **locations.shp**



Create paths from locations:

4. Apply HAWTHSTOOLS >>> ANIMAL MOVEMENTS >>> CONVERT LOCATIONS TO PATHS tool to **locations.shp** using a concatenated field (**con**) to identify groups of locations by criteria (e.g. bear ID, season, and year) and order/sort by **LOC_ID**
5. Check beside 'Make each segment a separate line' and name the output **paths.shp**



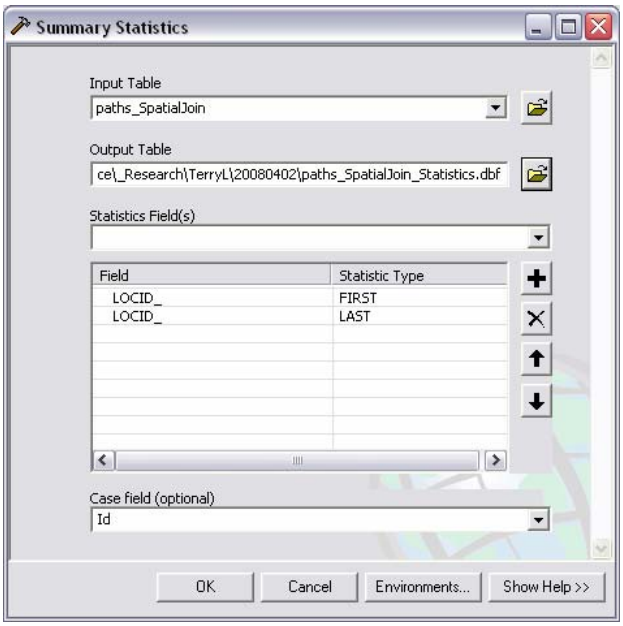
Attribute segments – unique ID and length.

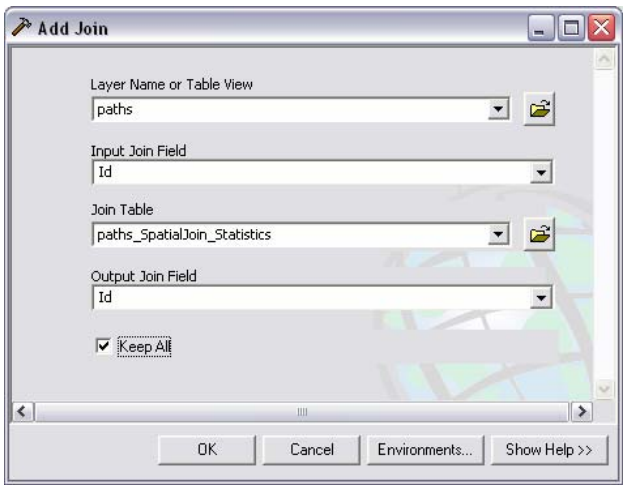
6. OPEN ATTRIBUTE TABLE for paths.shp
7. Right-click on the **Id** field heading and click FIELD CALCULATOR
8. Type the expression: **[FID] + 1**
9. Click OK
10. Use HawthsTools >>> Table Tools >>> ADD LENGTH FIELD TO TABLE (arcs)

Add point location ID to path segments:

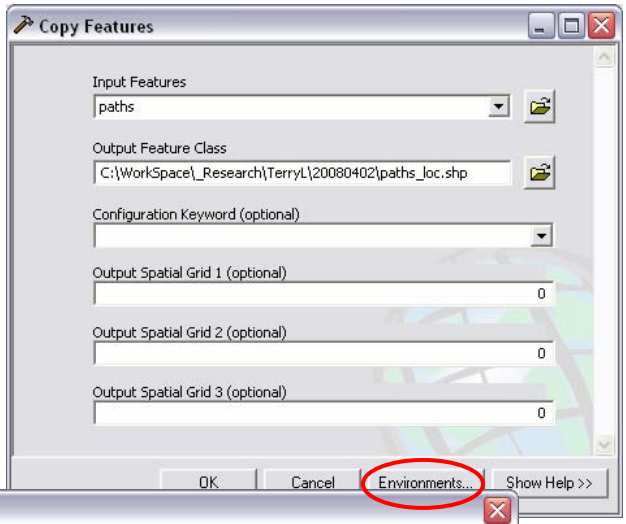
11. In ArcToolbox, open the ANALYSIS TOOLS >>> OVERLAY >>> SPATIAL JOIN tool
12. Specify the following parameters:
    - Target Features: paths
    - Join Features: locations
    - Join Operation: JOIN_ONE_TO_MANY
    - All else defaults
13. Click OK

14. In ArcToolbox, open the ANALYSIS TOOLS >>> STATISTICS >>> SUMMARY STATISTICS tool
15. Specify the following parameters:
    - Input Table: paths_SpatialJoin
    - Output Table: **paths_SpatialJoin_Statistics.dbf**
    - Statistics Fields/Types: **LOCID_/FIRST** and **LOCID_/LAST**
    - Case field: **Id**
16. Click OK
17. In ArcToolbox, open the DATA MANAGEMENT TOOLS >>> JOINS >>> ADD JOIN tool
18. Specify the following parameters:
19. Layer Name: **paths**
20. Input Join Field: **Id**
21. Join Table: **paths_SpatialJoin_Statistics**
22. Output Join Field: **Id**
23. Click OK

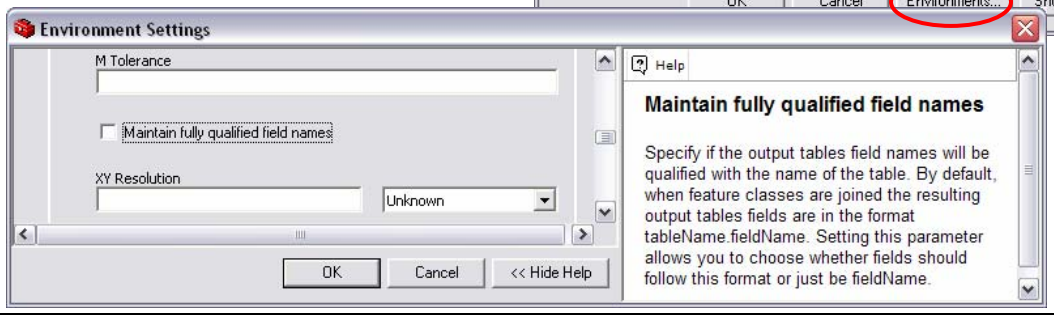




Join by attributes and export data to new shapefile.



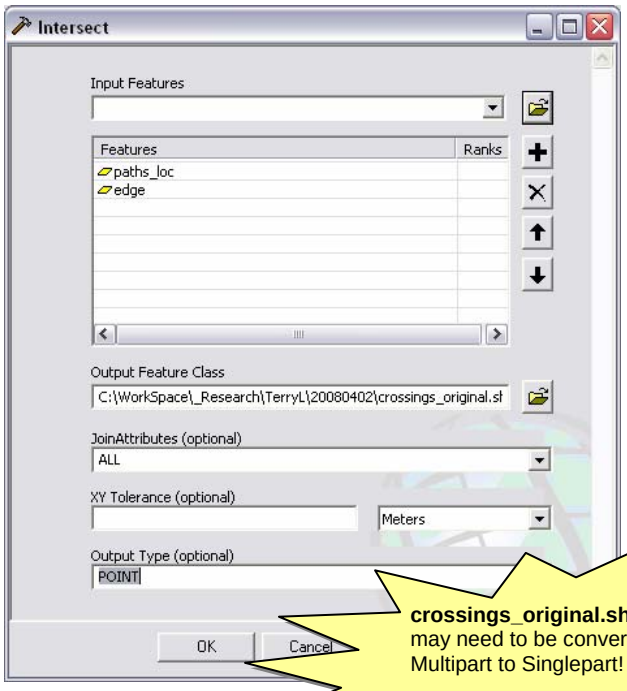
24. In ArcToolbox, open the DATA MANAGEMENT TOOLS >>> FEATURES >>> COPY FEATURES tool



25. Specify the following parameters:
    1. Input Features: **paths**
    2. Output Feature Class: **paths_loc.shp**
    3. Click the ENVIRONMENTS button
    4. Expand the GENERAL settings and **uncheck** 'Maintain fully qualified field names'
26. Click OK

The output provides a copy of the path segments that has the first and last identifying attribute (e.g. LOCID_) from the original point locations. This can be used in future attribute joins.

Create crossing points:

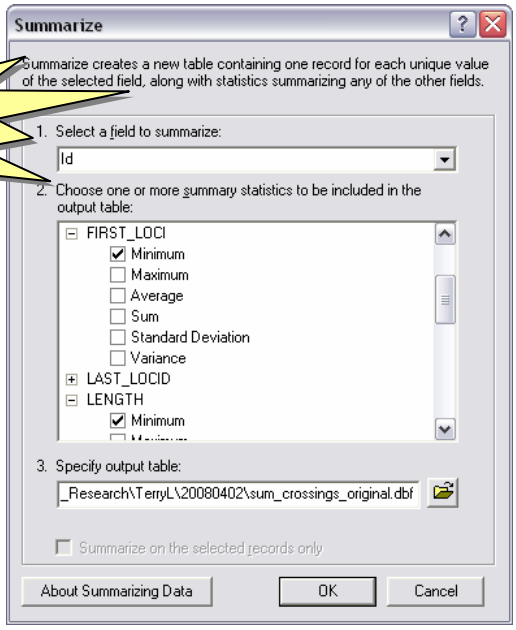


1. ADD DATA: **edge.shp**

Intersect paths with edge layer to identify path crossing points

2. In ArcToolbox, open ANALYSIS TOOLS >>> OVERLAY >>> INTERSECT
3. Specify the following parameters:
4. Input Features: **paths_loc**, **edge**
5. Output Feature Class: **crossings_original.shp**
6. Output type: **POINT**
7. Click OK

crossings_original.shp may need to be converted Multipart to Singlepart!

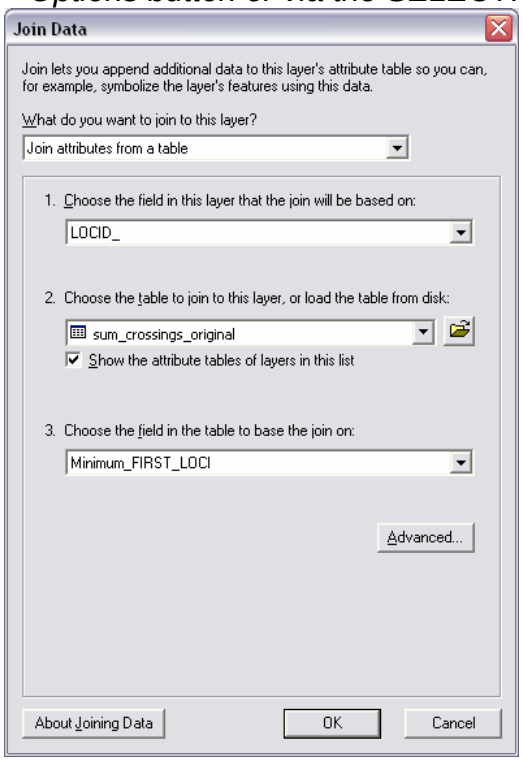


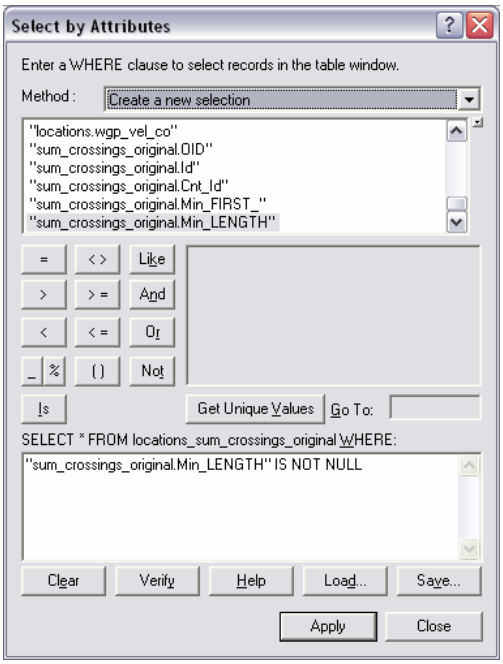
Generate random path segments from starting/end points related to original crossing points

First identify the starting points.

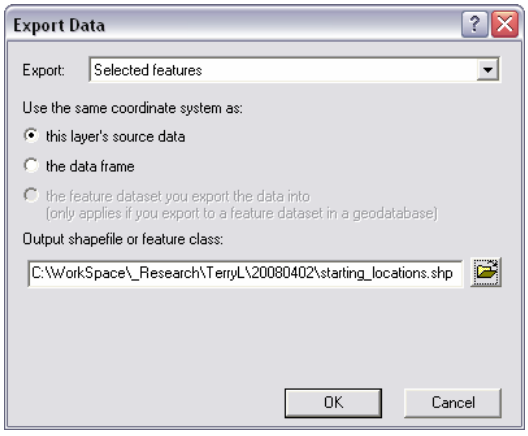
8. SUMMARIZE **crossings_original.shp** by **Id** field to identify paths that cross edges, using the summary statistics **FIRST_LOCI/Minimum** and **LENGTH/Minimum** to output **sum_crossings_original.dbf** *(Right-click on the Id field heading of the open attribute table to click Summarize, or use the ArcToolbox tool SUMMARY STATISTICS)*

9. JOIN BY ATTRIBUTES **locations** to **sum_crossings_original.dbf** using the LOCID_ and Minimum_FIRST_LOCI fields *(Right-click the locations name in the table of contents to access Joins and Relates >>> Joins, or use the ArcToolbox tool: ADD JOIN)*
10. OPEN ATTRIBUTE TABLE for **locations.shp** and SELECT BY ATTRIBUTES where **"sum_crossings_original.Min_LENGTH" IS NOT NULL** *(Click the Options button or via the SELECTION pull-down menu or ArcToolbox…)*





11. EXPORT DATA to create new layer based on the selected features to output **starting_locations.shp** *(Right-click locations in the table of contents and click Data >>> Export Data)*
12. ADD FIELDS and CALCULATE as shown in the table:

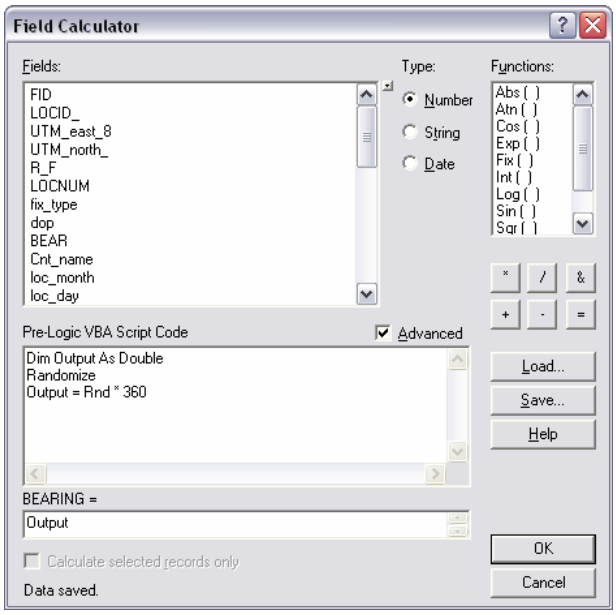


Field Name	Type	Equals =
DISTANCE	Double	[Min_LENGTH]
BEARING	Double	*Pre-Logic VBA Script Code* Dim Output As Double Randomize Output = Rnd * 360 *BEARING* = Output

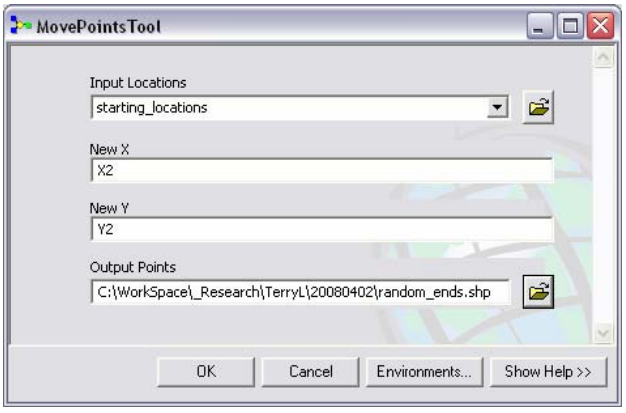
These fields are needed for the MovePointsByField in the next step.

13. Run the custom model tool MOVEPOINTSBYFIELD on starting_locations.shp to output **random_end.shp**

14. MERGE starting_locations.shp and random_end.shp to output **random_locations.shp**



15. Use HAWTHSTOOLS >>> ANIMAL MOVEMENTS >>> CONVERT LOCATIONS TO PATHS tool with random_locations.shp – multiple paths by **con** and order by **LOC_ID**



16. Check beside 'Make each segment a separate line' and name the output **random_paths.shp**

Intersect random paths with edge layer to identify crossing points

17. INTERSECT random_paths.shp and edge.shp to POINTS output **crossings_random.shp**

crossings_random.shp may need to be converted to Singlepart!

Optionally, merge path crossings with random crossings

18. ADD FIELDS to each of crossings_original.shp and crossings_random.shp:
    - Name: SOURCE
    - Type: Text
19. CALCULATE as the layer name; e.g. "original" or "random"
20. MERGE crossings_original.shp and crossings_random.shp to output **crossings.shp**

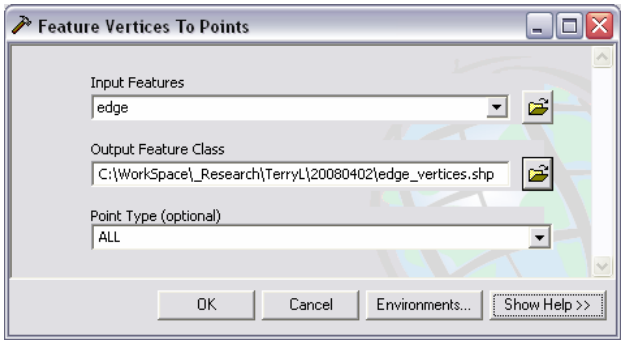
Create edge and landscape characterization layers:

Identify shape of edge

Two options for quantifying edge shape are detailed below. The first converts the edge polygons to vertices (points) and then the number of vertices can be counted within a 'buffer'. The second converts the edge polygons to polylines that can have their length summed within a 'buffer' to provide linear density.

1. In ArcToolbox, open DATA MANAGEMENT TOOLS >>> FEATURES >>> FEATURE VERTICES TO POINTS
2. Specify the following parameters:

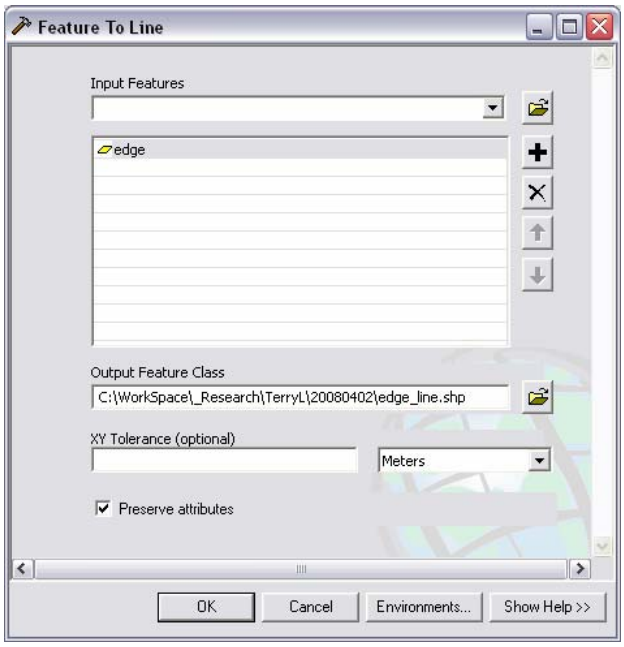
- Input Features: **edge**
- Output Feature Class: **edge_vertices.shp**
- Point Type: **ALL**



3. Click OK

Set Spatial Analyst Options and then access the Raster Calculator to apply the PointStats() function with the NPOINTS statistics on the edge vertices using a consistent (e.g. 25 m) radius to simulate 'buffers' around each crossing point.

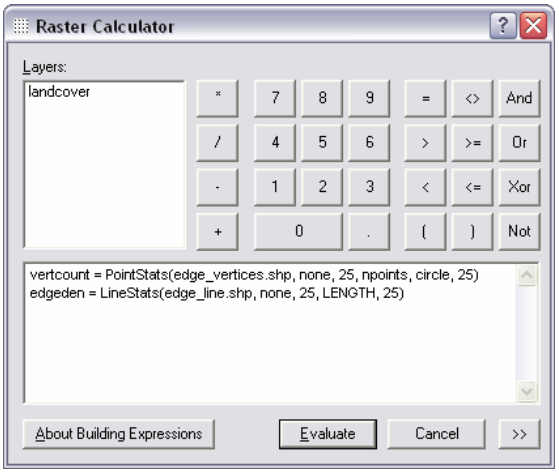
4. Click SPATIAL ANALYST >>> OPTIONS
   - Set the Working Directory
   - Set the EXTENT to 'Same as Layer landcover'
   - Set the CELL SIZE to 'Same as Layer landcover'
5. Click OK



6. Click SPATIAL ANALYST >>> RASTER CALCULATOR
7. Enter the following expression:

vertcount = PointStats(edge_vertices.shp, none, 25, npoints, circle, 25)

8. Click EVALUATE
9. In ArcToolbox, open DATA MANAGEMENT TOOLS >>> FEATURES >>> FEATURE TO LINE
10. Specify the following parameters:
    - Input Features: **edge**
    - Output Feature Class: **edge_line.shp**
11. Click OK



12. Click SPATIAL ANALYST >>> RASTER CALCULATOR
13. Enter the following expression:

edgeden = LineStats(edge_line.shp, none, 25, LENGTH, 25)

14. Click EVALUATE

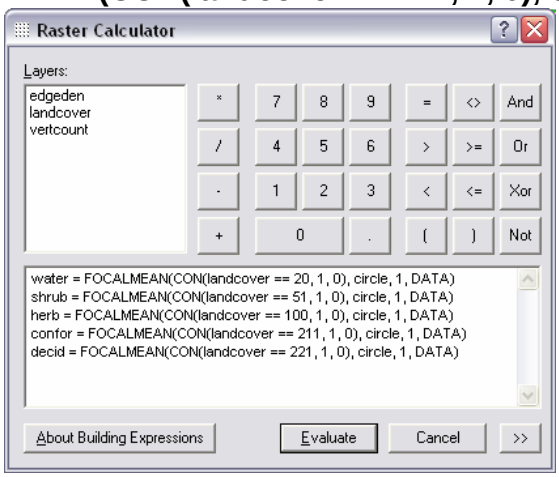
Make sure the SPATIAL ANALYST >>> OPTIONS are still 'Same as Layer landcover' (above) for the next steps.

Identify landcover types

See http://www.biology.ualberta.ca/facilities/gis/uploads/instructions/AVRSFLayers.pdf for related informational instructions. Apply multiple FocalMean(Con()) functions on the landcover raster using a consistent (e.g. 25 m) radius to simulate 'buffers' around each crossing point. The output rasters represent proportion of each class.

15. Click SPATIAL ANALYST >>> RASTER CALCULATOR and enter the following expressions:

water = FOCALMEAN(CON(landcover == 20, 1, 0), circle, 1, DATA)
shrub = FOCALMEAN(CON(landcover == 51, 1, 0), circle, 1, DATA)
herb = FOCALMEAN(CON(landcover == 100, 1, 0), circle, 1, DATA)
confor = FOCALMEAN(CON(landcover == 211, 1, 0), circle, 1, DATA)
decid = FOCALMEAN(CON(landcover == 221, 1, 0), circle, 1, DATA)



16. Click EVALUATE

Note: Substitute your actual landcover values in the above, and using as many landcover classes as your analysis requires. Again, see the related documentation on http://www.biology.ualberta.ca/facilities/gis/?Page=485 >>> Instruction sets for ArcGIS™ 9.x: ***Layer Variables for RSF-type Modelling Applications*** *.XLS.*

Intersect crossing points with characterization layers:

1. Use HawthsTools >>> Analysis Tools >>> Point Intersect Tool specifying the following parameters:
   - Point file to intersect: **crossings**
   - Layers to intersect with: all results from pointstats(), linestats(), and/or focalmean(con())
2. Click OK
3. OPEN ATTRIBUTE TABLE for crossings and click OPTIONS >>> EXPORT to a *.dbf or other format for your statistics