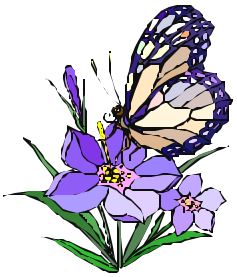
Measuring the Lengths of "Receiving" Polygon Edges

These instructions enable you to create shapefiles that represent the edge along a receiving polygon that may then be used in the analysis of potential movement between meadows (or other habitat patches). For example, if a butterfly travels from one meadow to the next, you may want to know: ***How long of an edge does the butterfly have access to in the next (or "receiving") meadow?*** By mapping out and calculating these receiving edges, you may then incorporate the values into more complex modeling. Using ESRI®'s ArcGIS 8.x software, you perform the following tasks:



- Convert the meadow polygons to edge lines
- Convert the meadow polygons to node points
- Create convex hulls around pairs of meadow nodes
- Intersect the meadow edges with the convex hull
- Calculate the length and select the required information

You need to install the **XTools** extension created by Igor Popov and Maxim Chikinev (available at http://arcscripts.esri.com/) if not already present in your ArcMap™ application. Two additional VBA scripts are required for node extraction (***Shapes to Points*** by Dan Rathert) and convex hull generation (***Convex Hull*** by Michael Sawada).

✱ Additional instruction on how to identify and calculate distances between the nearest meadow features is appended below. This bonus material uses ArcView 3.x with an extension called **Nearest Features** by Jeff Jenness. You may wish to perform these tasks *first* to identify meadow pairs that are closest to each other, and then use this information as your basis for the receiving meadow analysis.

ORIGINAL DATA

Meadows.shp	Shapefile of meadow polygons; ensure that you have a well-defined "**`MEADOW_ID`**" field of data type "Text" (the generic field name "ID" can get overwritten)

CREATED DATA

Meadow_lines.shp	Shapefile of meadow edges created from converting the Meadows.shp polygons
Meadow_nodes.txt	Delimited text table of nodes extracted from Meadows.shp
Meadow_nodes.shp	Shapefile of the nodes
Chull1.shp	Shapefile of the convex hull surrounding selected node pairs
Edge_pair1.shp	Shapefile of meadow lines that intersect the convex hull

Steps in ArcGIS 8.x:

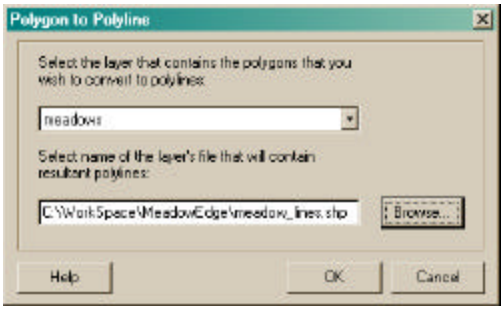
The **MEADOW_EDGE.mxd** map document (available to download from http://www.biology.ualberta.ca/facilities/gis/index.php?Page=485) has the required VBA scripts already set up for your use.

Setting up the map document:

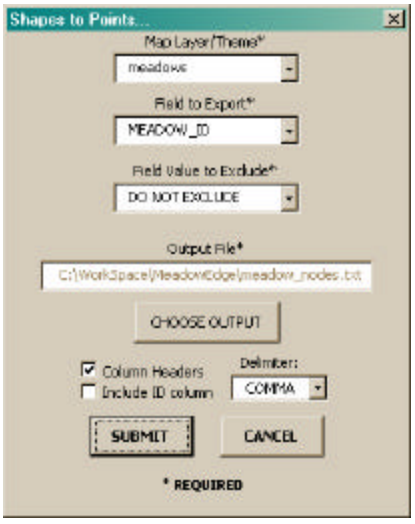
1. Start **ARCMAP**
2. Start using with the MEADOW_EDGE.mxd OR start using an empty map document and install the required VBA form scripts and attach to toolbar buttons (*see "readme" documentation with the downloads for detailed installation instruction*)
3. Click the ADD DATA button and add the **meadows.shp** data 
4. Choose FILE → SAVE AS
5. Save as a new file name; e.g. **meadow_edge_date.mxd**

Converting between vector feature types:

For subsequent tasks, you will need the meadow polygons converted to lines (edges for use in the intersection step) and points (nodes for use in the convex hull creation). Converting to lines is easily done with XTools.



6. Choose XTOOLS → FEATURE CONVERSIONS → CONVERT POLYGONS TO POLYLINES 
7. Select **meadows** as the input layer
8. Specify an output shapefile; e.g. **meadow_lines.shp**
9. Click OK



*The conversion to node points is a two -step process that takes advantage of the **Shapes to Points** script.* 

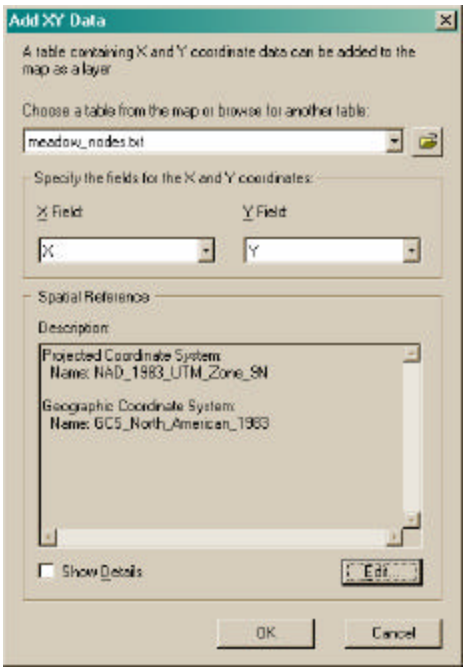
10. Click on the SHAPE TO POINTS button (*the one you added – or the one that appears like the button at right if you started with the MEADOW_EDGE.mxd*)
11. Select/specify the following parameters in the Shape to Points dialog box:
    - **meadows** layer as the map layer/theme
    - **MEADOW_ID** as the field to export
    - DO NOT EXCLUDE any field values
    - **meadow_nodes.txt** as the output text table
    - check beside "Column Headings"
    - COMMA as the delimiter

12. Click SUBMIT

You should get a message that the operation was successful. The text table output can be displayed using the XY Data tool.

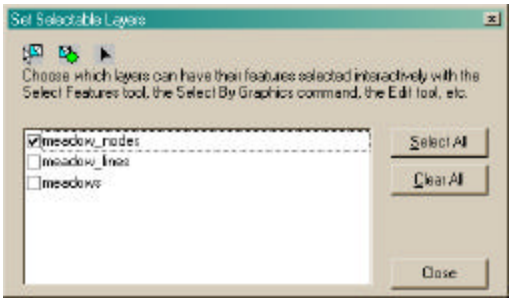
13. Choose TOOLS → ADD XY DATA
14. Click the BROWSE button and navigate to the directory containing **meadow_nodes.txt** to select it
15. ArcMap automatically fills in the X and Y fields.
16. Click the EDIT button and IMPORT the **meadows.shp** spatial reference
17. Click OK

The Event layer that is added represents the nodes defining the shape of the meadow polygons. Once the data is exported as a shapefile, these points can be selected and used for convex hull creation.



18. In the table of contents, right click on **meadow_nodes.txt** Event
19. Choose DATA → EXPORT DATA in the pop-up menu
20. Leave all else at their defaults and specify an output name; e.g. **meadow_nodes.shp**
21. Add the new layer to the map document when prompted

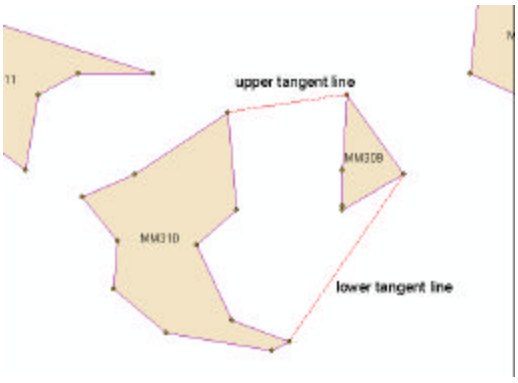
Creating the convex hull:



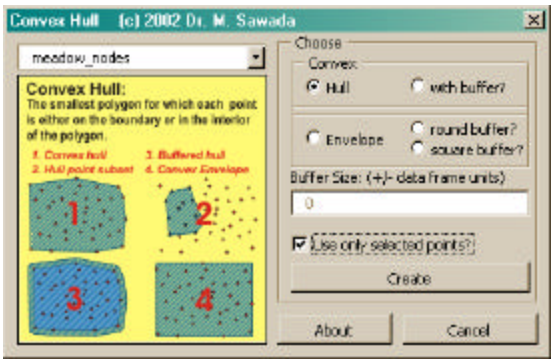
*Set the **meadow_nodes.shp** layer as the only selectable layer for this part.*

22. Choose SELECTION → SET SELECTABLE LAYERS
23. Click CLEAR ALL to quickly remove all check marks
24. Click in the check box beside **meadow_nodes** to set it as selectable
25. Click CLOSE
26. ZOOM IN to an area where you want to work on two meadow polygons 

*A convex hull is a polygon that encompasses the outermost points of a set of points. It is a method often used for creating animal home ranges called Minimum Convex Polygons (MCPs). The reason for its use here is to indirectly locate the upper and lower tangent lines that visually connects meadow pairs as shown in the diagram. To do this, you must **first select the set of points** to be used.*



27. Use the SELECT FEATURES tool OR choose SELECTION → SELECT BY ATTRIBUTES
28. Interactively select OR perform your selection query (e.g. **`"MEADOW_ID" = 'MM309' OR "MEADOW_ID" = 'MM310'`**) for both sets of nodes in the two meadows of interest
29. Click on the CONVEX HULL button

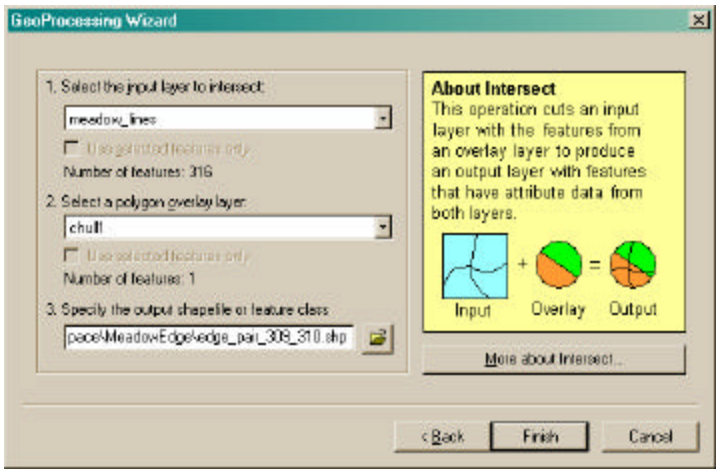


30. Select **meadow_nodes** as the input points
31. Click a check beside "Use only selected points?"
32. Leave all else at their defaults
33. Click CREATE
34. Specify an output name; e.g. **chull1.shp**
35. Click SAVE
36. In the table of contents, click and drag **chull1.shp** so that it draws below all other layers

Intersecting meadow edges:

Using the GeoProcessing Wizard, you can easily determine the spatial coincidence of the meadow edges with the convex hull. Remember that the convex hull is an indirect method of obtaining the upper and lower tangents between the meadow polygon pairs. These tangents are part of the convex hull, but are NOT spatially coincident with any part of the meadow polygons. It is where there is meadow edge inside the convex hull that you may measure as the "receiving" edge. Note: due to the complex shapes of some meadow polygons, you may need to modify the intersection results to get your required length measures. The intersection overlay operation resolves this important spatial coincidence of edges for you.

37. Choose TOOLS → GEOPROCESSING WIZARD
38. Choose INTERSECT as the method
39. Click NEXT
40. Select **meadow_lines** as the input layer
41. Select **chull1** as the polygon overlay layer
42. Specify and output shapefile name; e.g. **edge_pair1.shp**
43. Click FINISH
44. In the table of contents, right click on edge_pair1.shp
45. Click on OPEN ATTRIBUTE TABLE



46. In the table, select each of the records in turn to highlight the corresponding lines in the data view display window
47. Click OPTIONS → CLEAR SELECTED FEATURES
48. Start an edit session (*within the EDITOR toolbar*) and DELETE the non-receiving edges (*Or simply ignore these and record the ones of interest by selecting them only before continuing the next section on calculating length*.)

Calculating length:

*In the attribute table, you may update the "**PERIM**" field OR add a new Double type field named "**LENGTH**."*

49. To add a field, click on OPTIONS → ADD FIELD
50. Specify "**LENGTH**" as the name, **Double** as the type, **12** for the precision (number of digits), and **4** for the scale (number of decimal places)
51. Click OK
52. Right click on the field name ("**LENGTH**" or "**PERIM**")
53. Choose CALCULATE VALUES
54. Load the **Return_Length.cal** expression (from Easy Calculate by http://www.ian-ko.com/) OR copy the VBA from the ArcGIS Desktop Help file ***"Making field calculations"*** → ***"Updating length for a shapefile"***
55. To input your own expression, check ADVANCED
56. In the first box type in the following:

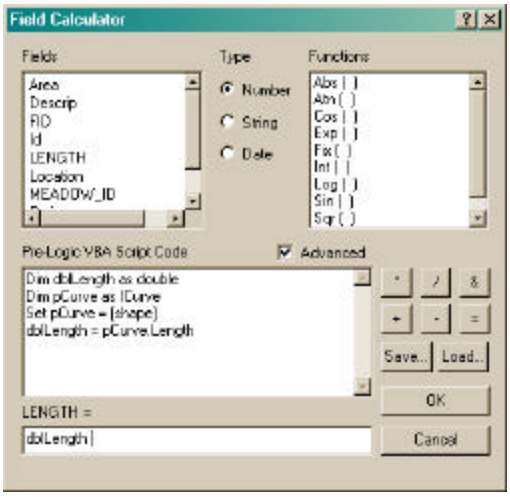
```
Dim dblLength as double
Dim pCurve as ICurve
Set pCurve = [shape]
dblLength = pCurve.Length
```

57. In the "LENGTH = " box, type the following:

```
dblLength
```

58. Click OK

The length is now calculated for the receiving edges as determined by the intersection.

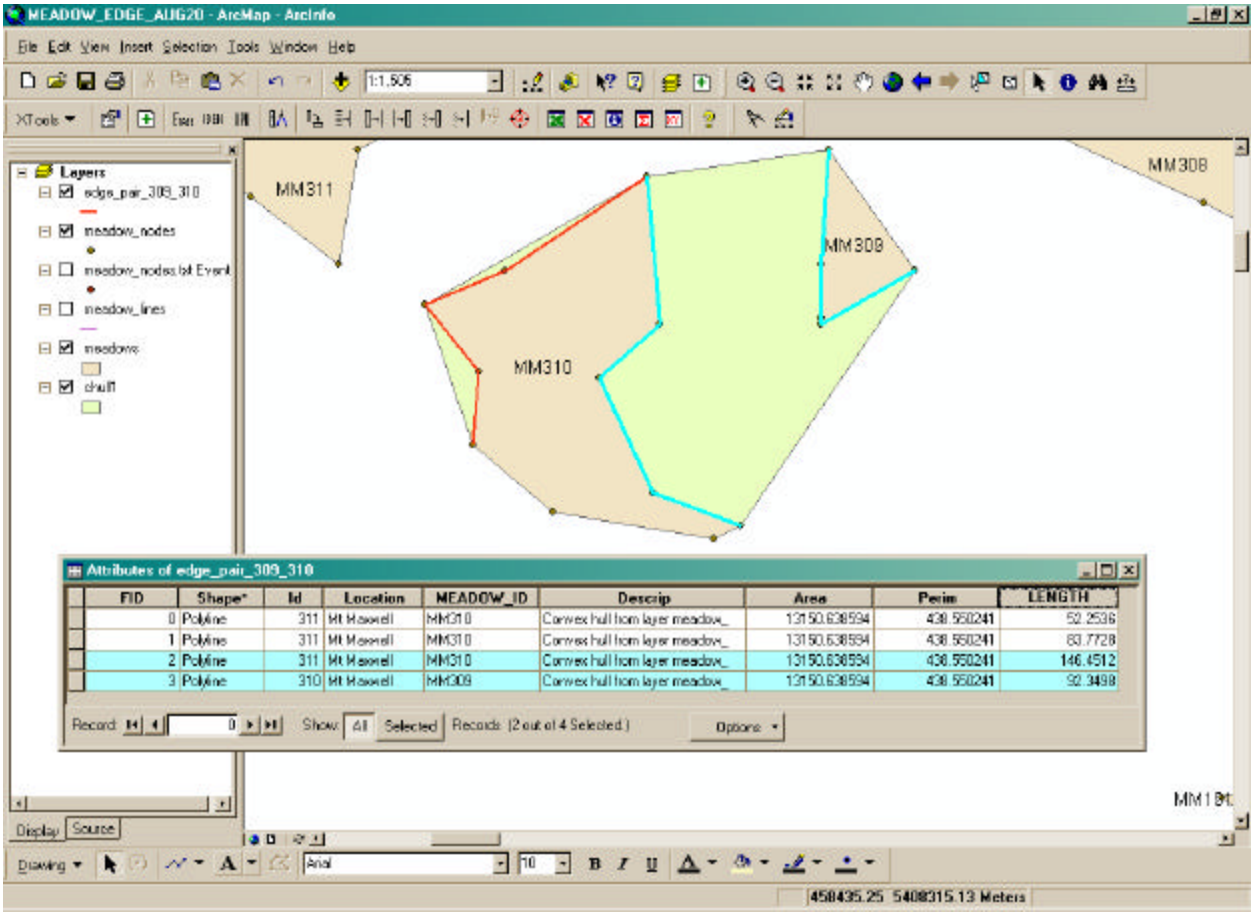


Repeating for other meadow pairs:

Unfortunately, a fully automated method is not yet available. You must measure the edge lengths of each meadow pair by repeating the steps:

- Creating the convex hull
- Intersecting meadow edges
- Calculating length

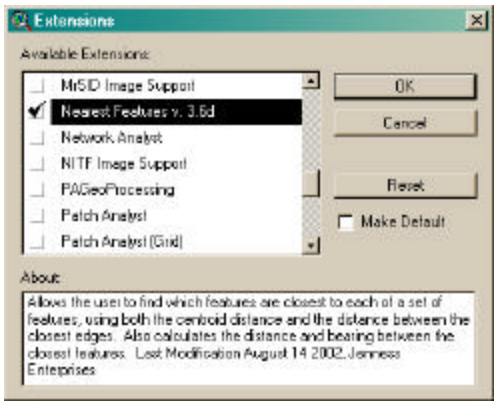
Try creating all convex hulls, merging them into one shapefile, and then performing the intersection once. Make sure you add a new field to use in labeling each convex hull in the merged file with it's original filename (i.e. MEADOW_ID pair) so that you know what "chull" polygon gets intersected with what meadow edge!



The above diagram shows the final results of the edge analysis. If a butterfly was to travel from one meadow to the other, you can easily identify the potential edges of the receiving meadow and determine their length.

Steps in ArcView 3.x:

The following provides additional instruction on how to identify and calculate distances between the nearest meadow features is appended below. This bonus material uses ArcView 3.x with an extension called **Nearest Features** by Jeff Jenness (available at http://arcscripts.esri.com/). Obtain the .avx file and place it in ArcView's EXT32 directory.



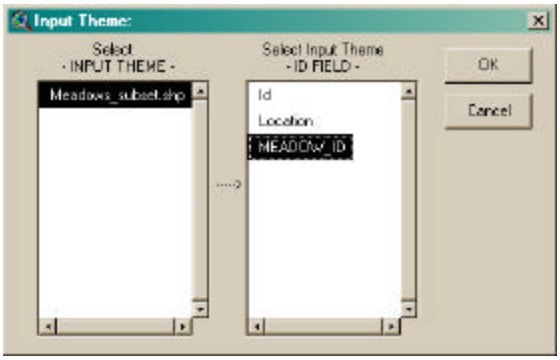
Setting up the project:

1. Start **ARCVIEW GIS 3.x**
2. In a new view, add the **meadows.shp** theme
3. Load the required extension.
4. Choose FILE → EXTENSIONS

5. Scroll down until you find NEAREST FEATURES
6. Click a check beside it
7. Click OK
8. Choose FILE → SET WORKING DIRECTORY
9. Specify your working directory; e.g. **C:\WorkSpace\MeadowEdge**
10. Choose VIEW → PROPERTIES
11. Specify the MAP and DISTANCE UNITS; e.g. **meters**
12. Save the project; e.g. **nearest_meadows.apr**

Finding nearest features:

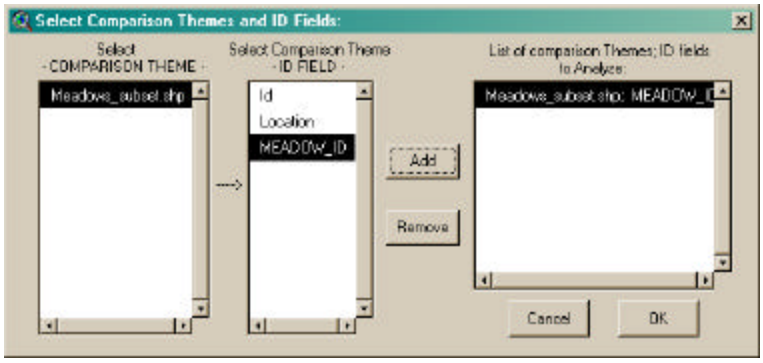
13. Click on the NEAREST FEATURES button 



14. Select **meadows.shp** as the input theme
15. Select **MEADOW_ID** as the input field
16. Click OK

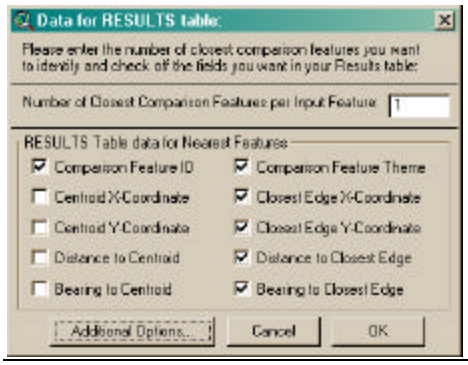
Since you want to compare all meadows with each other, simply select the same theme for the next step.

17. Select **meadows.shp** as the comparison theme
18. Select **MEADOW_ID** as the comparison field
19. Click ADD
20. Click OK

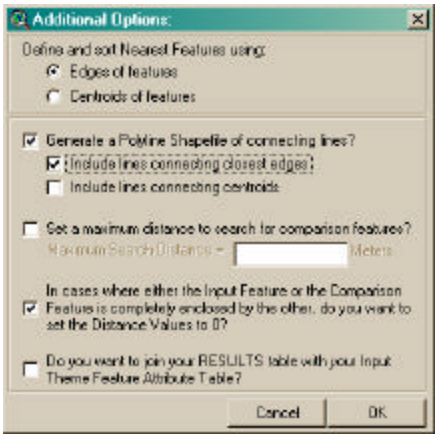


In the next dialog box, specify the output fields you want in the RESULTS table.

21. Fields for this analysis:
    - Comparison Feature ID
    - Comparison Feature Theme
    - Closest Edge X-Coordinate
    - Closest Edge Y-Coordinate
    - Distance to Closest Edge
    - Bearing to Closest Edge
22. Click ADDITIONAL OPTIONS

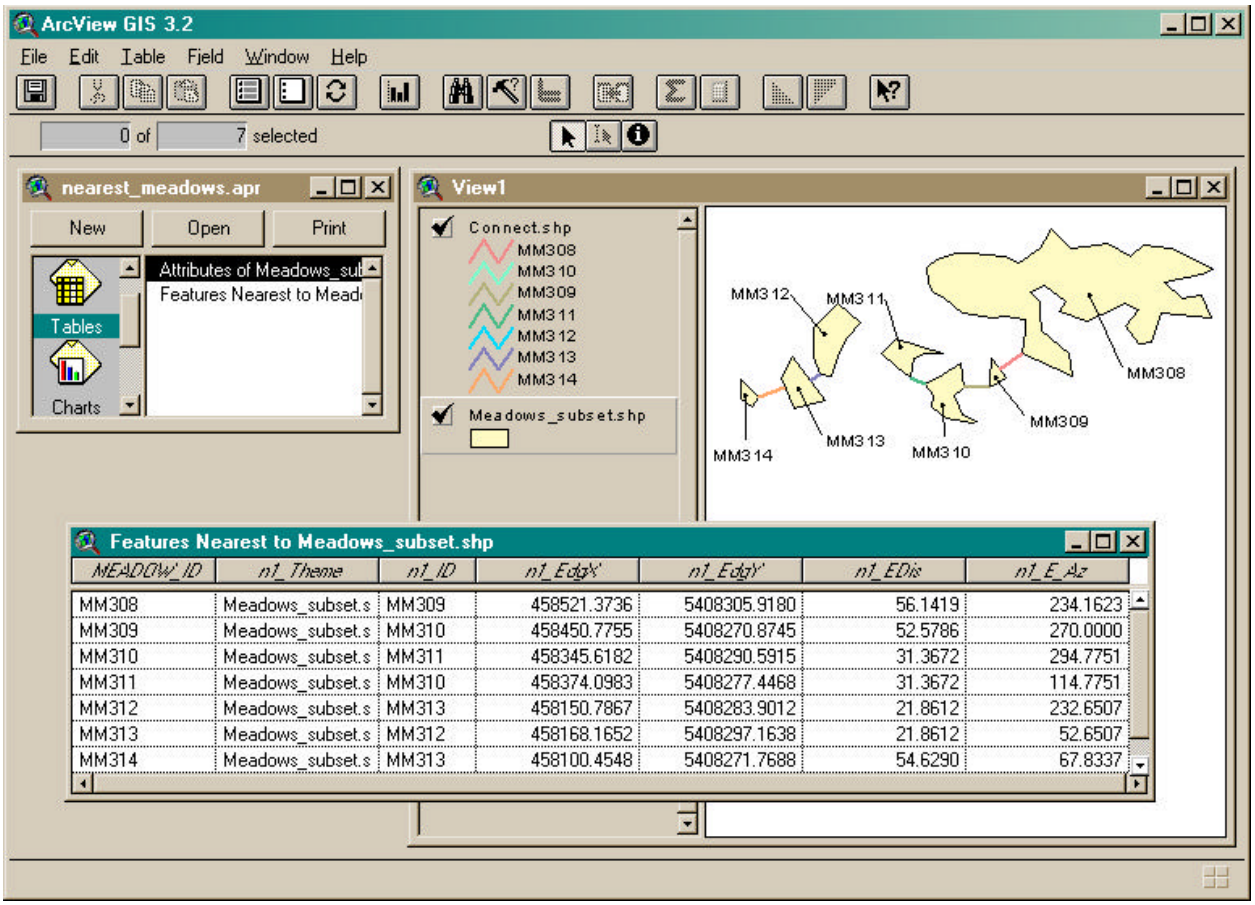


23. Check the options you want
24. Click OK
25. Click OK two more times (and specify any additional options asked for that you



may want)

26. Specify the output names and locations for the results table and connect shapefile
27. Click OK
28. Turn on the connect shapefile theme
29. Examine the results table



MEADOW_ID	n1_Theme	n1_ID	n1_EdgX	n1_EdgY	n1_EDis	n1_E_Az
MM308	Meadows_subset.s	MM309	458521.3736	5408305.9180	56.1419	234.1623
MM309	Meadows_subset.s	MM310	458450.7755	5408270.8745	52.5786	270.0000
MM310	Meadows_subset.s	MM311	458345.6182	5408290.5915	31.3672	294.7751
MM311	Meadows_subset.s	MM310	458374.0983	5408277.4468	31.3672	114.7751
MM312	Meadows_subset.s	MM313	458150.7867	5408283.9012	21.8612	232.6507
MM313	Meadows_subset.s	MM312	458168.1652	5408297.1638	21.8612	52.6507
MM314	Meadows_subset.s	MM313	458100.4548	5408271.7688	54.6290	67.8337

The X and Y coordinate field values may be used to map out an event theme of the closest point location along the meadow edge. You may also repeat the NEAREST FEATURES operation to obtain the second nearest, or higher order of nearest meadows. See the documentation that comes with the extension when you download it from at http://arcscripts.esri.com/.