Appendix 6

GIS Analysis

Data preparation (JH)

The spatial assessment of biodiversity benefits was performed using ArcView 3.2 GIS. ArcView was used rather than ArcGIS owing to its broader user-base and the fact that the Patch Analyst extension is currently only available for ArcView.

Input GIS layers:

- Mapped onground works in various projections (AGD1996 /Vicmap)
- Vegetation layer
- Aerial photography or Landsat image (optional)
- Roads, town, watercourses used for the locator map.

The aerial photography can be used to help interpret the maps of vegetation and onground works. If the onground works were partially, or not attributed, approximate assumptions of the actions (either remnant protection or revegetation) could be made. Polygons, which overlayed more than 50 % of a remnant, were classified as remnant protection along with those classified in the database, and those identified on the satellite or aerial photography as being over unmapped remnants e.g. riparian vegetation. Further classification into more refined categories such as remnant enlargement, remnant enhancement, revegetation for erosion or riparian restoration could be made with more time and local knowledge.

The change in vegetative cover over the subcatchment was based on an initial merged layer of existing vegetation (before) then enlarged by a layer of all onground works which occurred outside the existing vegetation layer (after). This included proposed works and eliminated instances when works intersected (e.g. revegetation occurring in a remnant protection block or completed works over proposed polygon).

Patch Analyst for ArcView (AZ)

1. Introduction

Patch Analyst is a freely available suite of extensions for ArcView GIS which allows users to spatially analyse landscapes. It focuses on landscape spatial metrics such as connectivity, nearest neighbour analysis, edge-area ratios, contiguity and other indices. Patch Analyst is available for raster and vector data models (GRIDS and Shapefiles) with the raster version using the algorithms developed for Fragstats, the stand-alone landscape analysis software. Patch Analyst can be downloaded from http://flash.lakeheadu.ca/~rrempel/patch/ and requires ArcView GIS. To use the Patch Grid option in Patch Analyst, ArcView Spatial Analyst is required and all data must be converted to raster format (GRID format). The raster version of Patch Analyst offers a number of additional landscape indices not available in the vector version. Foremost of these indices is nearest neighbour analysis, core area analysis and some additional diversity and interspersion metrics.

Patch Analyst adopts a hierarchy of analysis based on the concept of landscapes, classes and patches and allows users to derive metrics for either of these. A landscape includes all the patches, classes and polygons in a study area. A class includes all patches, polygons, contiguous cells or shapes in a theme or landscape that have the same value for a given attribute. Each individual polygon or contiguous set of identical grid cells is a patch. Each patch has a separate record, or row, in the theme attribute table (or grid value) (Patch Analyst Help File, 2003).

2. Performing an Analysis

The following example assumes that Patch Analyst extension has been installed correctly and enabled (Figure 1 and instructions available at http://flash.lakeheadu.ca/~rrempel/patch/) and that Spatial Analyst is installed. The example focuses on the derivation of the nearest neighbour index for a landscape containing newly revegetated patches. The nearest neighbour index provides an estimate of the connectivity inherent in the landscape. Users are encouraged to explore the suite of other landscape indices available in Patch Analyst as they may have more relevance for their case study.

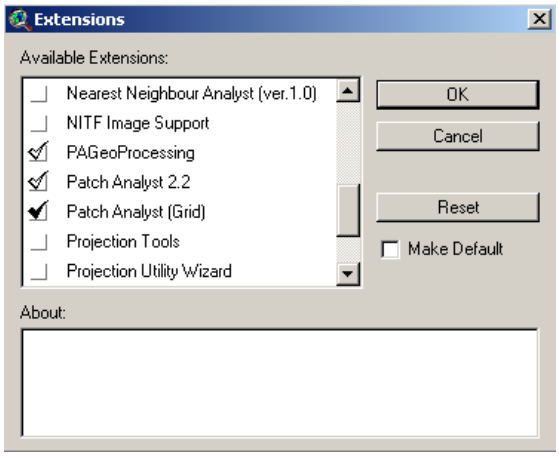


Figure 1. Enabling the Patch Analyst Extension in ArcView

Figure 2 shows the ArcView interface and the PatchGrid drop-down menu being used to perform an analysis. In this simple example we will extract the nearest-neighbour index for this hypothetical landscape. The example data is in ArcView GRID format. From the PatchGrid menu select Spatial Statistics (PatchGrid>Spatial Statistics).

Figure 3 shows the Patch Analyst interface for selecting landscape metrics for analysis. In our case study we will calculate the Mean Nearest Neighbour Distance, Number of Patches, Mean Patch Size, Total Edge and some Diversity and Interspersion metrics. Our analysis will be at the Landscape level as our data shows either vegetated or non-vegetated patches. In some instances, for example when dominant species information is available for each patch, a Class level analysis may be appropriate.

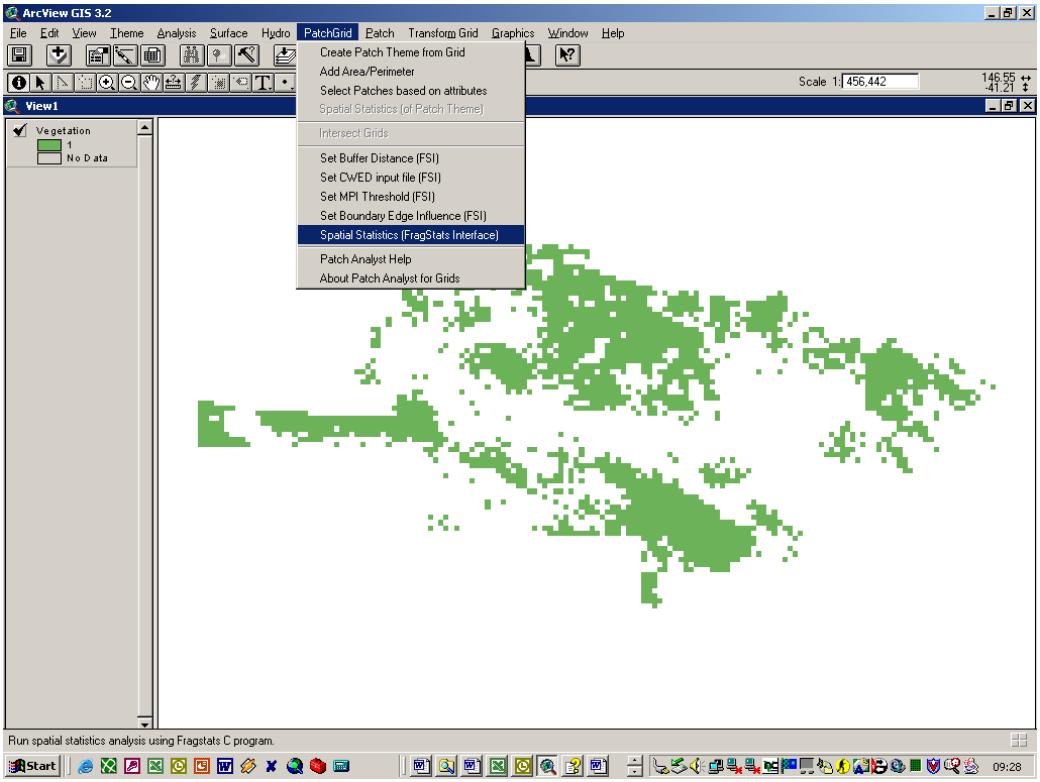


Figure 2. ArcView window showing an example raster data set of newly revegetated landscape in raster format (GRID). The drop-down menu shows the PatchGrid interface for calculating spatial indices for raster data.

Results from a Patch Analyst analysis are written to an ArcView table and appear as those shown in Figure 4. The Patch Analyst help file will be required to interpret the column headings. In the analysis conducted, we can see that our hypothetical landscape has an inter-patch mean nearest neighbour distance of 183.00 metres, it contains 1197 contiguous patches and the mean patch size is 250.68 metres. Users are encouraged to explore the suite of Patch Analyst options available and begin comparing statistics for different landscapes, classes or for different landscape management scenarios.

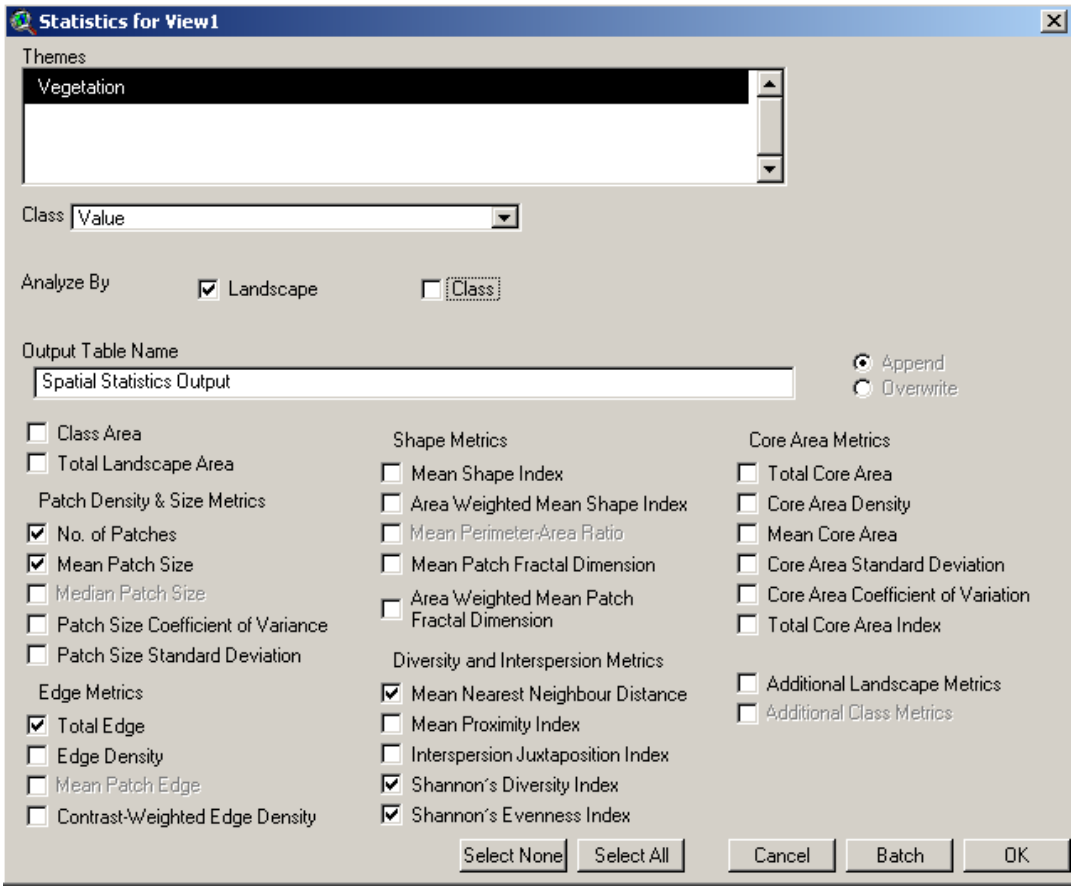


Figure 3. Patch Analyst interface for selecting landscape metrics for analysis

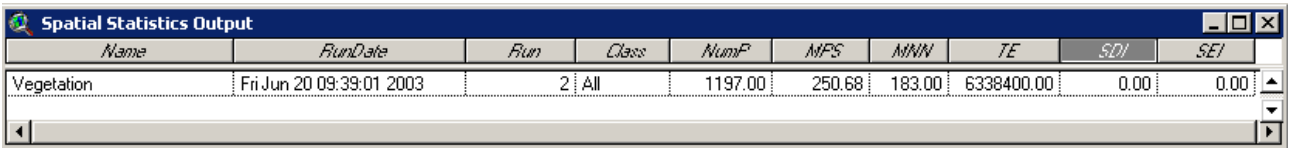


Figure 4. Patch Analyst interface for selecting landscape metrics for analysis

Notes:

- As Patch Analyst calculates distance metrics, it is critical that the correct map units are firstly defined in ArcView (View>Properties). Failing to do so will result in erroneous Patch Analysis indices.

Distance to Core measurements (JH)

Core areas of greater than 10 ha were extracted from the existing vegetation layer and saved as a new dataset. This dataset (currently a vector Shapefile) was converted to a raster data model (GRID format). Using the Spatial Analyst 'Find Distance' function, a distance to core areas raster was produced showing concentric circles of distance intervals around each core area.

To calculate the 'before' distance to core, all the remnants less that 10 ha were assigned latitude and longitude centroids using an Avenue script (addxy.ave) (see appendix) that adds coordinates to the Shapefile attribute table. This enable the 'remnant bits' to be added to the View as an ArcView 'Event Theme' showing the centroid of each remnant as a point data model. An Avenue script called Interpolate.ave (see appendix) was run to extract the distance to the core area for each remnant centroid. Distances are added to the centroids attribute table and show the distance in meters to each core area. Calculating the mean of these distances provides a mean distance to core area before onground works commenced.

To calculate the 'after' distance, onground works were merged with the 'remnant bits', converted to points and placed on the 'distance to core area' surface. The average of the distance measurements produced by the Interpolate.ave script became the mean distance to core area after onground works.

Developing And Analysing A Patch Distance Matrix (AZ)

(This is used for calculating the mean distance to the 5 nearest neighbours. As the excel steps are restricted to 256 columns it needs to be carried out on a sub sample of remnant patches. The calculation was carried out for Saltshaker but it was considered too time consuming to be applied to sub-samples from other projects)

This document describes the use of ArcView GIS and Microsoft Excel for generating simple measures for assessing changes to landscapes. In this first component, we introduce the use of the distance measures to assess average inter-patch distances. For this analysis we will utilise two publicly available extensions/scripts for ArcView, and an Excel Macro to format and analyse our distance file:

- Dmatrix_en.avx – a publicly available ArcView extension for creating a distance matrix
- Addxy.ave – An Avenue script that adds latitude and longitude coordinates to a Shapefile.
- Distancematric.vba – A Visual Basic macro that processes a distance matrix into a format for statistical analysis using histograms.

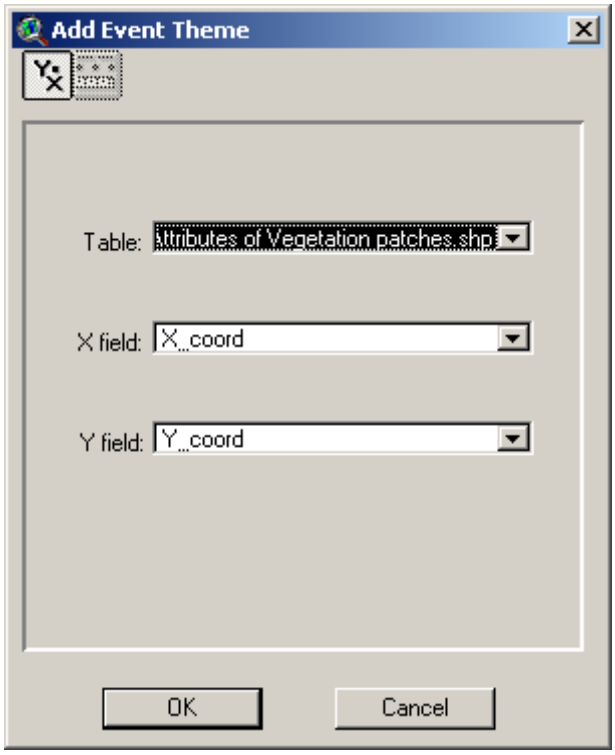
1. Using Arcview To Create An Inter-Point Distance Matrix

a. The first stage of the process is to convert all the polygons to points showing the centroid of each polygon. All proceeding analysis is performed on point features.

b. Add the Shapefile containing polygons that define each vegetation patch.

c. Load the script called AddXY.ave to ArcView and run this script using the vegetation patch file as the input. This will add two new columns to the attribute table of the polygon shapefile called X-coord, and Y-coord.

d. These coordinates will be used to create a new Shapefile containing point features using the View>Add Event Theme option. Select this option from the menu and fill in the appropriate options as shown below.



e. A new theme will be added to the ArcView view called 'Attributes of Vegetation Patches.shp' or some other similar name depending on the naming convention of your files. This file needs to be written to a permanent Shapefile by selecting Theme>Convert to Shapefile and added to the view.

f. We can now start creating a distance matrix to show the distance from each patch to every other patch.

g. The purpose of using the "dmatrix_en.avx" ArcView extension is to calculate the distance between the set of points presented in one theme in the ArcView View and create a matrix embedding the distance values between these points. For instance, if the theme has 5 points, the output distance matrix will take the form:

IDs	**Point1_ID**	**Point2_ID**	**Point3_ID**	**Point4_ID**	**Point5_ID**
Point1_ID	0	Dist. 1 2	Dist. 1 3	Dist. 1 4	Dist. 1 5
Point2_ID	Dist. 2 1	0	Dist. 2 3	Dist. 2 4	Dist. 2 5
Point3_ID	Dist. 3 1	Dist. 3 2	0	Dist. 3 4	Dist. 3 5
Point4_ID	Dist. 4 1	Dist. 4 2	Dist. 4 3	0	Dist. 4 5
Point5_ID	Dist. 5 1	Dist. 5 2	Dist. 5 3	Dist. 5 4	0

h. Copy the "dmatrix_en.avx" extension to the EXT32 folder of your ArcView program. To run the extension use the following command: File >Extensions. The extension box will appear on your screen. Scroll down until you locate the extension "Distance Matrix of Point Features". Check that extension then click OK.

i. In your View window a new button  will appear in the button bar. This button will enable you to create the distance matrix, however some formatting is required before we generate our distance matrix.

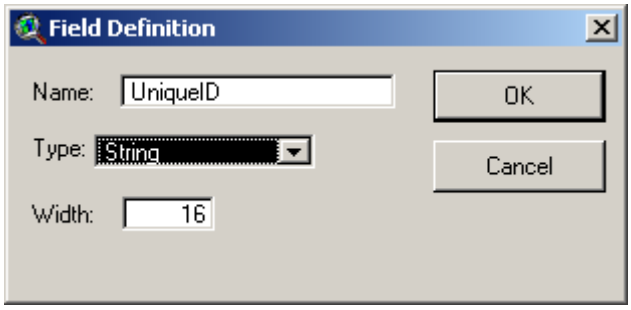
j. A few things need to be in place before you can run this extension.

   i. Firstly, set the View units to the appropriate unit (View>Properties).

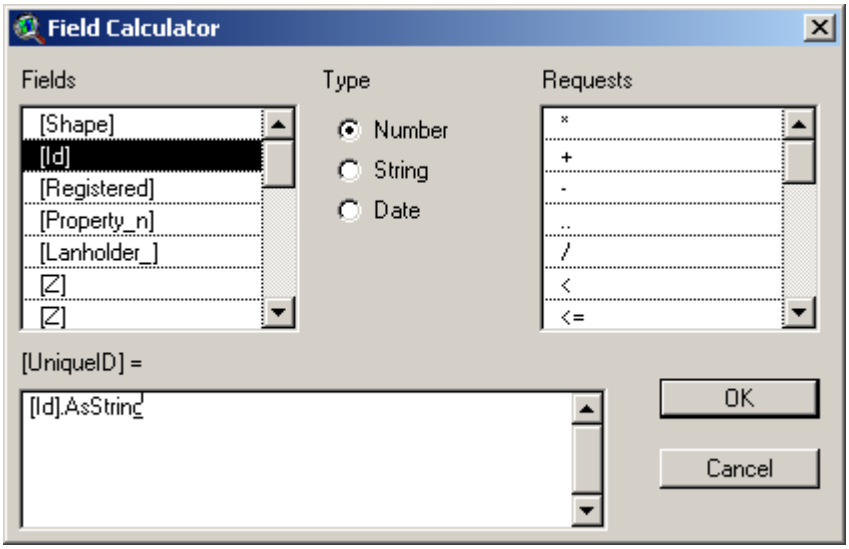
   ii. A string type field must exist that provides a unique ID for each point in the Shapefile. These unique values will be used to identify the column and row headings of the distance matrix.

   iii. Most unique feature identifiers in a Shapefile will be of numeric format hence we need to convert this to a string field.

   iv. Create a new field in the table, defined as a string and call it something logical such as UniqueID.



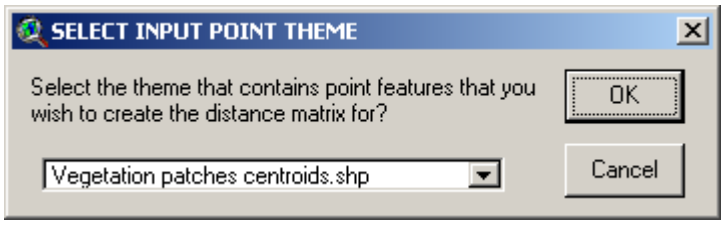
   v. Highlight this field, and using the Field Calculator (Field>Calculate), perform the following calculation which populates the new field with a String type containing a unique ID for each point.



vi. The data is now ready to be converted to a distance matrix.

k. We will now create our distance matrix by selecting the Σ button

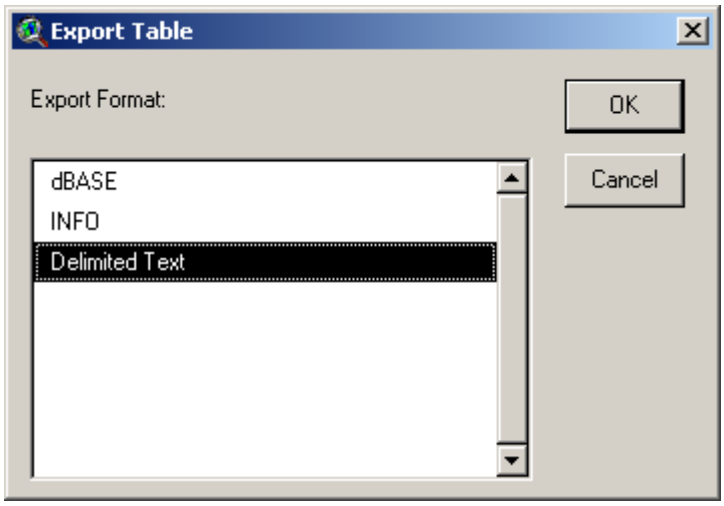
l. As the input, select the Shapefile that contains the new unique feature identifier and latitude and longitude.



m. Select the field containing the new String format unique feature identifier

n. The distance matrix will be saved under the file name you choose and a table will appear in your ArcView window as a copy of that dbf file that contains the distance between the different point features.

o. A more robust file is created if we Export the ArcView table to a delimited text file and use this in Excel (File>Export)



3. Using Excel to Analyse the Distance Matrix

Start Excel and open up the newly created Distance Matrix which shows the distance between all patches to all other patches. The following Visual Basic for Applications (VBA) sample code should be inserted into the Excel file containing the distance matrix values. This code generates a continuous string of distances by transposing the distance matrix. The results can be used to generate frequency and cumulative frequency histograms to show the distribution of inter-patch distances for each study area. Standard Excel statistical analysis can also be performed to calculate average inter-patch distances, standard deviations and other numerical estimates of landscape connectivity.

```
Sub DistanceMatrixProcess()
' DistanceMatrixProcess Macro
' Created 21/05/2003 by Andre Zerger
' Program converts a symmetrical matrix to a continuous string of values
' for use performing statistical analysis (frequency histograms).

 increment = 0
 rowOut = 2

'Start with row number 2 and move down the rows in the file
'For 235 colums, set upper value of r to 235
 For r = 2 To 235
          'Move along the columns, and increment the starting column
     'value depending on the row number that is being processed
           For c = 3 To (235 - increment)
                     Sheets("AllFinal").Select
                     Cells(c + increment, r).Copy
                     Sheets("test").Select
                     Cells(rowOut - 1, 1).Select
                     ActiveSheet.Paste
              rowOut = rowOut + 1
    Next c
   'Decrement the row value along the diagonal matrix for each row incremented
   'to initialise a new starting row value
              increment = increment + 1
```

```
Next r
End Sub
```

Using the following macro all the columns in the distance matrix can be sorted, thus allowing the calculation of the mean nearest neighbour and the mean of the 5 nearest neighbours.

```
Sub Macro1()
' Find K Nearest Neighbours
' Macro developed by Andre Zerger, CSIRO Sustainable Ecosystems

' Macro is used to sort columns in order to find K number of nearest
' neighbours from a distance matrix

Dim c As Integer
For c = 2 To 250
    Sheets("After sorted").Columns(c).Select
    Selection.sort Key1:=Cells(1, c), Order1:=xlAscending, Header:=xlYes, _
       OrderCustom:=1, MatchCase:=False, Orientation:=xlTopToBottom
Next c
End Sub
```

4. Appendix

ADDXY.ave

An Avenue script that adds latitude and longitude coordinates to a Shapefile

```
' Name: View.AddXYCoordToFTab
'
' Title:  Adds X and Y coordinates of features to Attribute Table
'
' Topics:  GeoData
'
' Description:  Adds two new fields, named X-coord and Y-coord, to the table
' of the first active theme in the TOC and fills the respective fields with
' the X,Y coordinates of the selected points (or all points if no selection
' is defined) in a point theme.  If instead the active theme is a polygon
' theme, then the X,Y coordinates of the polygon centroid are calculated. If
' the theme is projected, the output coordinates will also be projected.
'
' Requires:  An active point or polygon theme. This script does minimal
' error checking and assumes that there is an active theme.
'
' Self:
'
' Returns:

theView = av.GetActiveDoc
'must be global to work in Calc exp below
_theProjection = theView.GetProjection
project_flag = _theProjection.IsNull.Not  'true if projected
theTheme = theView.GetActiveThemes.Get(0)

'Check if point or polygon theme
if (((theTheme.GetSrcName.GetSubName = "point") or
    (theTheme.GetSrcName.GetSubName = "polygon")).Not) then
  MsgBox.Info("Active theme must be polygon or point theme","")
  exit
end

'get the theme table and current edit state
theFTab = theTheme.GetFTab
theFields = theFTab.GetFields
edit_state = theFTab.IsEditable

'make sure table is editable and that fields can be added
if (theFtab.CanEdit) then
  theFTab.SetEditable(true)
  if ((theFTab.CanAddFields).Not) then
    MsgBox.Info("Can't add fields to the table."+NL+"Check write permission.",
    "Can't add X,Y coordinates")
```

```
    exit
  end
else
  MsgBox.Info("Can't modify the feature table."+NL+
  "Check write permission.","Can't add X,Y coordinates")
  exit
end

'Check if fields named "X-coord" and Y-coord" exist
x_exists = (theFTab.FindField("X-coord") = NIL).Not
y_exists = (theFtab.FindField("Y-coord") = NIL).Not

if (x_exists or y_exists) then
  if (MsgBox.YesNo("Overwrite existing fields?",
  "X-coord, Y-coord fields already exist", false)) then
    'if ok to overwrite, delete the fields as they may not be defined
    'as required by this script (eg., created from another script).
    if (x_exists) then
      theFTab.RemoveFields({theFTab.FindField("X-coord")})
    end
    if (y_exists) then
      theFTab.RemoveFields({theFTab.FindField("Y-coord")})
    end
  else
    exit
  end  'if (MsgBox...)
end  'if

x = Field.Make ("X-coord",#FIELD_DECIMAL,18,5)
y = Field.Make ("Y-coord",#FIELD_DECIMAL,18,5)
theFTab.AddFields({x,y})

'Get point coordinates or polygon centroid coordinates
if (theTheme.GetSrcName.GetSubName = "point") then
  if (project_flag) then
    'Projection defined
    theFTab.Calculate("[Shape].ReturnProjected(_theProjection).GetX", x)
    theFTab.Calculate("[Shape].ReturnProjected(_theProjection).GetY", y)
  else
    'No projection defined
    theFTab.Calculate("[Shape].GetX", x)
    theFTab.Calculate("[Shape].GetY", y)
  end  'if
else  'polygon case
  if (project_flag) then
    theFTab.Calculate("[Shape].ReturnCenter.ReturnProjected(_theProjection).GetX",
x)
    theFTab.Calculate("[Shape].ReturnCenter.ReturnProjected(_theProjection).GetY",
y)
  else
```

```
    theFTab.Calculate("[Shape].ReturnCenter.GetX", x)
    theFTab.Calculate("[Shape].ReturnCenter.GetY", y)
  end  ' if
end

'Return editing state to pre-script running state
theFTab.SetEditable(edit_state)
```

Interpolate.ave

An avenue script that mearure distanced between points and a distance to core area surface.

```
'grid2spots.ave
'written by mikael elmquist
theView = av.GetActiveDoc

theThemes={}
for each ttheme in theView.GetThemes
  if (ttheme.Is(Gtheme).Not) then
  see = ttheme.GetFtab.GetClass.GetClassName
    if (ttheme.GetFtab.findfield("Shape").gettype = #FIELD_SHAPEPOINT) then
      theThemes.Add(ttheme)
    end
  end
end
thePointTheme = MsgBox.ChoiceAsString(theThemes,"Select point theme that shall
get values from the grid theme.","GetGridValue")
if (thePointTheme = Nil) then
  exit
end
theFtab = thePointTheme.GetFtab

theThemes={}
if (theFtab.CanEdit) then
  theFTab.SetEditable(true)
  if ((theFTab.CanAddFields).Not) then
    MsgBox.Info("Can't add fields to the table."+NL+"Check write permission.",
    "Can't add grid values")
    exit
  end
else
  MsgBox.Info("Can't modify the feature table."+NL+
  "Check write permission.","Can't add grid values")
  exit
end


for each ttheme in theView.GetThemes
  if (ttheme.Is(Gtheme)) then
    theThemes.Add(ttheme)
  end
end
theGtheme = MsgBox.ChoiceAsString(theThemes,"Select grid that shall assign
values to the point theme.","GetGridValue")
if (theGtheme = Nil) then
  exit
end
theGrid = theGtheme.Clone.GetGrid.Clone
```

```
thePrj = Prj.MakeNull
varname = MsgBox.Input( "Enter new Variable Name", "Gridvalue", "add var-name"
)
'gridvalueField = Field.Make (varname,#FIELD_LONG,8,0)
gridvalueField = Field.Make (varname,#FIELD_DECIMAL,10,2)
theShapeField = theFtab.FindField("shape")
theFTab.AddFields({gridvalueField})




for each rec in theFtab
  theValue = theGrid.CellValue(theFtab.returnValue(theShapeField,rec),thePrj)
  if (theValue<>Nil) then
    theFtab.setValue(gridvalueField,rec,theValue)
  end
end

'*************
'Reset arcview
'*************
theFtab.Flush
theFtab.Refresh
av.purgeobjects
av.ClearStatus
av.ClearMsg
```