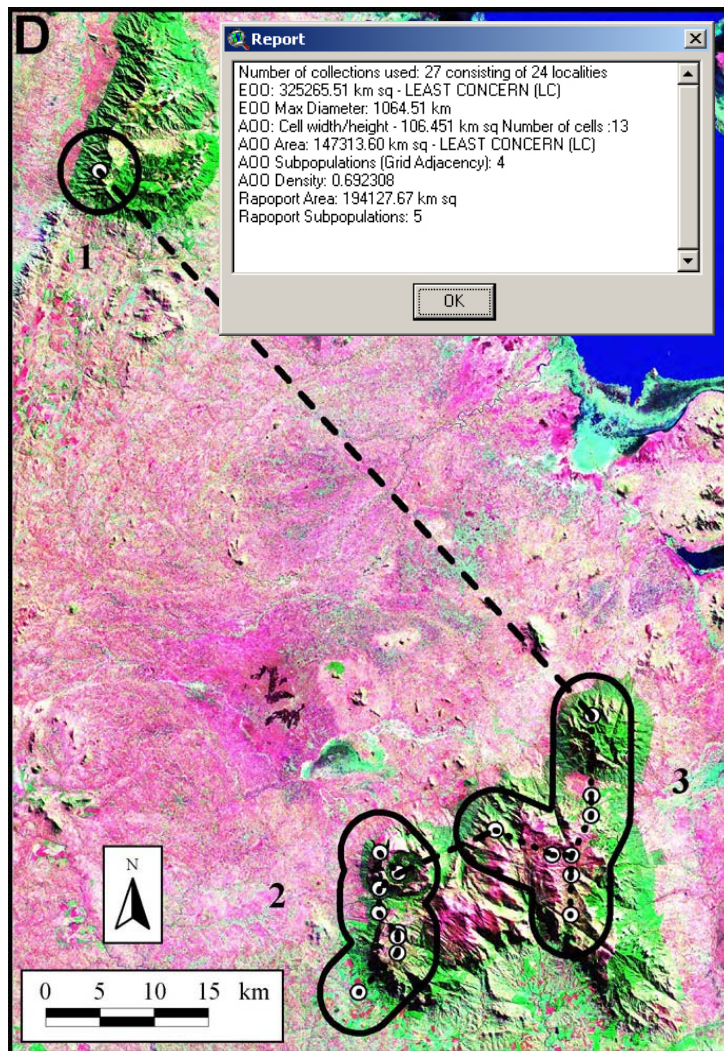


Extension Name: Conservation Assessment Tools

Description:

This extension provides a suite of tools designed to produce rapid conservation assessments based on IUCN Categories and Criteria (IUCN 2001). Preliminary conservation assessments based on extent of occurrence (EEO), area of occupancy (AOO), number of sub-populations and number of locations can be calculated either for single species or multiple species through a batch process.



File Name: cats.avx

Version: 1.2

Topics: ArcView, View, Analysis, Conservation, IUCN, Red List, EOO, AOO

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Requires: ArcView 3.1 or higher, point theme. NB not tested on ArcView 3.0, but should work.

Revision History: Version 0.1 November 2002
 Version 1.0 December 2007
 Version 1.1 January 2007
 Version 1.2 February 2008 (Public release)

Citation: Moat, J. 2007. Conservation assessment tools extension for ArcView 3.x, version 1.2. GIS Unit, Royal Botanic Gardens, Kew. Available at: <http://www.rbgkew.org.uk/gis/cats>

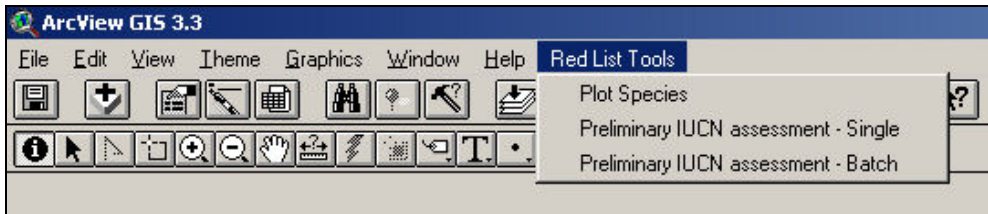
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Adding the extension:

- Place the extension file “CAT.avx” into the ArcView extensions folder e.g. \\ESRI\AV_GIS30\ARCVIEW\EXT32
- Open a new project and load the extension (File > Extensions...CAT)
- Loading the extension will add a new menu to the view toolbar:

Menu items:



Menu Item	Explanation
Plot Species	If a point theme contains multiple species the Plot Species tool can be used to create multiple themes based on a unique field.
Preliminary IUCN assessment - Single	Calculates a variety of measures relating to a species point distribution and outputs a preliminary threat rating based on the IUCN Categories and Criteria (IUCN 2001).
Preliminary IUCN assessment - Batch	Calculates the same measures in Preliminary IUCN assessment – Single for multiple species and outputs as a table.

Getting started:

The tools require a point theme that represents one or many species distributions. This theme need to be in geographic projection (Latitude and Longitude). Georeferenced specimen data can be added as a table and then converted to an event theme in the following way:

Add a **Table** with specimen data to the **Project**

Open a new **View**

Click **View > Add Event theme...**

Select the **Table** along with the decimal latitude and longitude fields

Click **OK** to add the **Theme** to the **View**

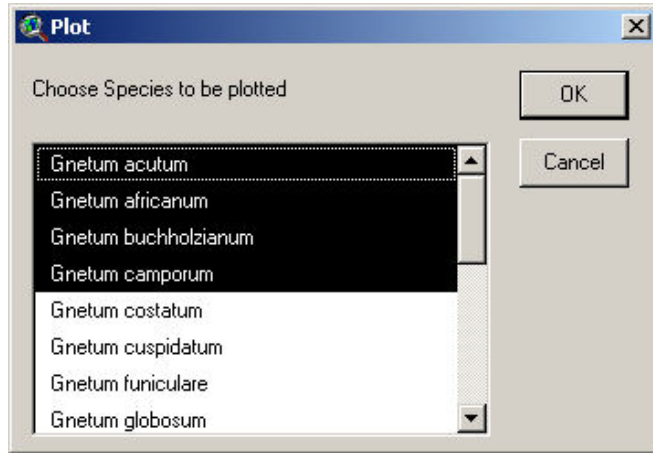
A more detailed explanation for each tool is given below:

1. Plot Species

The plot species tool enables the user to split a theme based on a unique field. Activate the theme you wish to query then select **Plot Species**. Select the field that you wish to group by e.g. "Species".



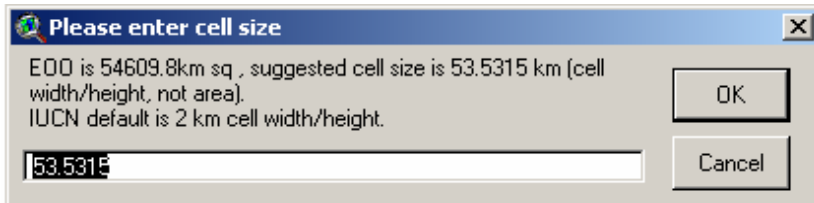
The next dialog box shows the grouped values. Select which ones are to be plotted and click **OK**. Multiple values can be selected by holding down the Shift or Control keys.



A new theme is created for each selected value and is plotted in the view with the name as listed in the unique field.

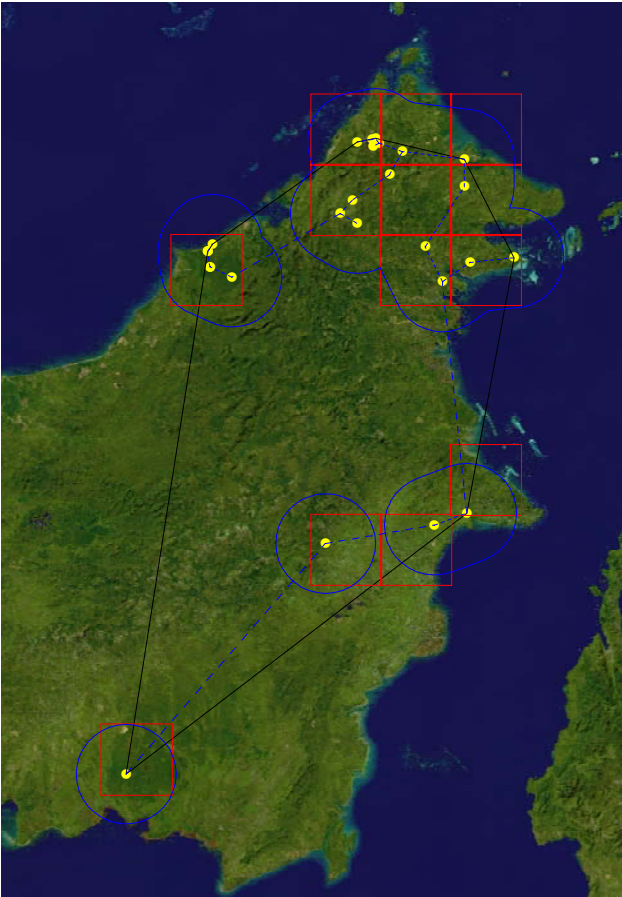
2. Preliminary IUCN assessment - Single

Select a point theme to run the analysis on e.g. a species point theme. Select **Preliminary IUCN Assessment – Single**. The user can enter the desired cell size (length) for the AOO (Area of Occupancy) measurement or use the value as suggested by the tool (see 'sliding scale' in the Explanation of results section). Click **OK** to run the preliminary IUCN assessment.



The preliminary assessment is calculated and a report window appears displaying the results of the analysis. Graphics are drawn in the view to show the various measures as shown below. The results are fully explained in the section 'Explanation of results'.

If points are selected, this tool will run on only the selected points, if no points are selected it will run on all points.



The black solid line is the convex hull (also known as minimum convex polygon) and represents Extent of Occurrence (EOO). The red cells represent 'occupied' areas or Area of Occupancy (AOO). Rapoport's mean propinquity technique for subpopulations is displayed with blue lines where the solid blue line delimits subpopulations, the short dot-dash line represents connected points in the same population and the long dot-dash line shows the connection between isolated points i.e. different subpopulations.

3. Preliminary IUCN assessment – Batch

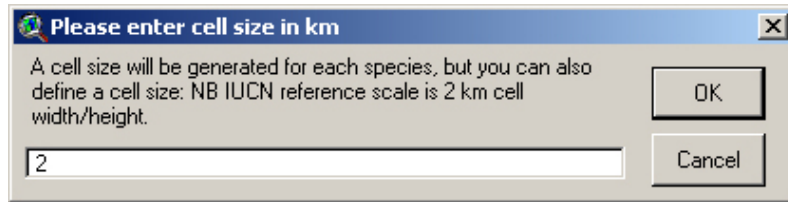
The batch option for the preliminary IUCN assessments will calculate the same measures as **Preliminary IUCN assessment - Single**, but for multiple species. The batch tool requires a point theme containing multiple species data in geographic projection. To run the analysis select **Preliminary IUCN assessment – Batch**. The user is asked to define the unique field e.g. species name. Define field and click **OK** or **Cancel** to exit.



The user is then asked to define the cell size for the AOO measurement. A cell size will be generated automatically when the tool is run using the sliding scale method, but the user can set a desired cell size which will also be used

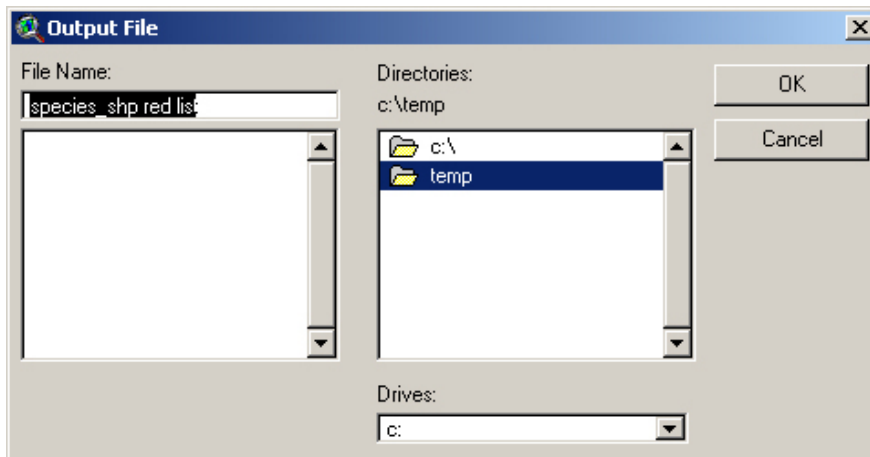
for all species in the theme. A reference scale of 2km cell width is given as a default. The preliminary analysis will be run using both the sliding scale and the user generated cell width or the 2km default if the user does not enter a cell size.

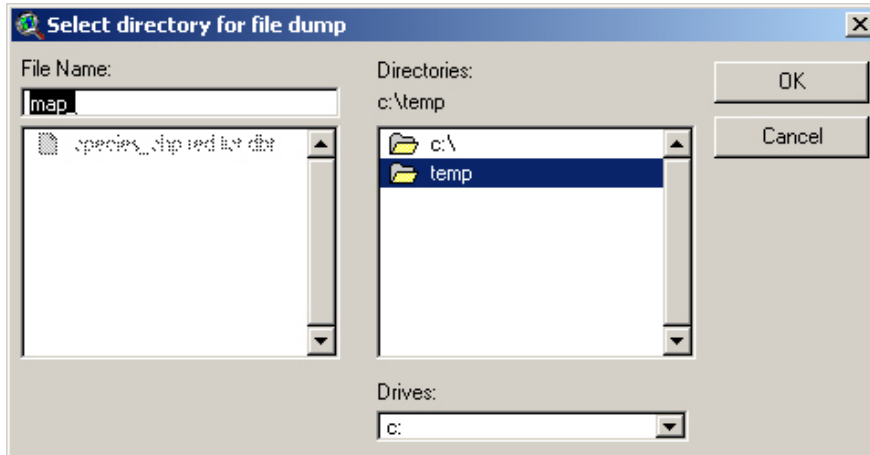
Click **OK** to continue or **Cancel** to exit.



The user is then asked for a location to save the output file (a table in .dbf format). Browse to a suitable location and then click **OK** or **Cancel** to exit.

The next window asks for a directory where the maps are to be saved. The prefix 'map_' is given as default. Click **OK** to continue or **Cancel** to exit.

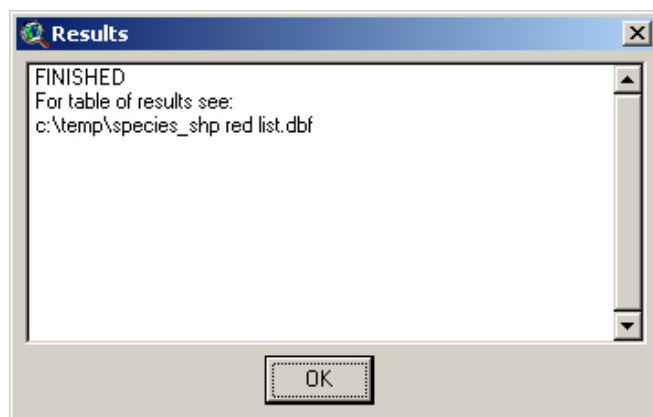




A window will tell you how many species will be processed, click **Yes** to continue and start the analysis. Each species will be queried and plotted on the map. The preliminary assessment analysis will be carried out and a map showing the analysis results for each species will be exported.

The process may take several minutes depending on how many species and point localities there are.

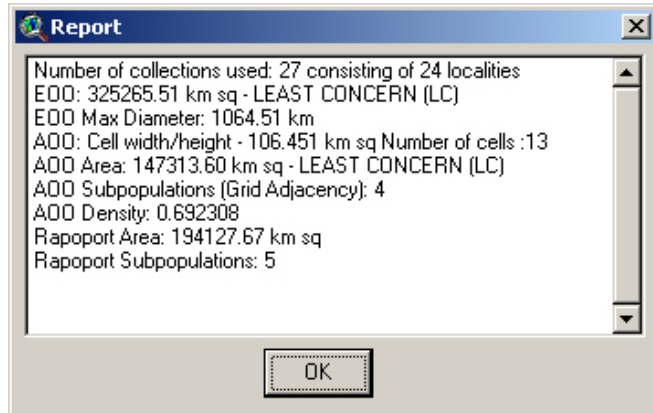
When all species have been analysed a **Results** window will appear. The table of results is saved in the location chosen and is automatically added to the project. The results are explained in full in the following section.



Explanation of results:

Preliminary IUCN assessment - Single

The output of the **Preliminary IUCN assessment – Single** is a text report with a number of measurements also drawn as graphics in the view. The various measures are explained below.



Number of collections

This is the number of unique records in the point theme. This is equivalent to unique specimen records.

Number of localities

Specimens georeferenced with the same co-ordinates are treated as the same locality. The definition of locality in this context is equivalent to a botanist's definition of a collection locality, not the IUCN definition of 'location', which incorporates the presence or absence of a threatening event.

EOO (Extent of Occurrence)

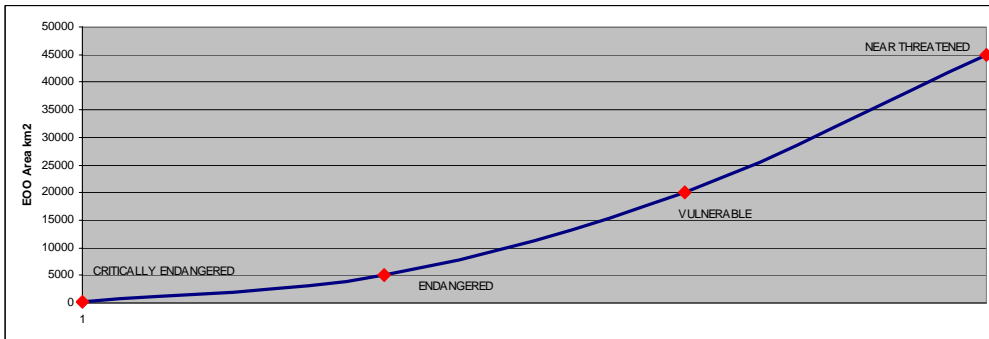
The convex hull or minimum convex polygon, used to define EOO, is a line drawn around all distribution points with no internal angle exceeding 180°. This is the same as imagining an elastic band being pulled over all the points. The value reported for EOO is the area within the black line and is measured in km². The convex hull can only be drawn when there are at least three unique distribution points or localities.

EOO rating

The EOO rating is based on the values as listed under the IUCN Categories and Criteria Version 3.1 (IUCN, 2001). The area value for EOO calculated above is compared with the thresholds set in Criterion B1 and the relevant rating is returned. The threshold values are as follows:

EOO (km ²)	Rating
<100	CRITICALLY ENDANGERED
<5000	ENDANGERED
<20,000	VULNERABLE
<45,000	NEAR THREATENED

It should be noted that the category of Near Threatened does not have a threshold in the IUCN Criteria. The value used in this tool has been extrapolated based on the power relationship between the other EOO values, see graph below.



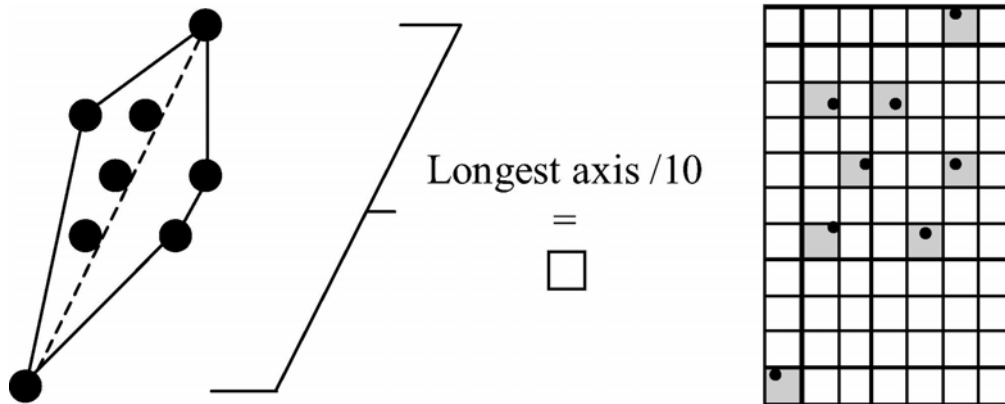
EOO Max Diameter

This is the maximum diameter or the longest axis across the EOO convex hull. The distance is measured in kilometres and is used to calculate the sliding scale AOO cell width.

AOO (Area of Occupancy) Cell width (sliding scale)

The width of the cell is reported in kilometres. The sliding scale cell width is generated using **EOO Max Diameter** as shown below:

$$\text{Sliding scale AOO cell width} = \text{EOO Max Diameter (longest axis)} / 10$$



AOO Number of cells

This is the number of cells that contain at least one point i.e. occupied.

AOO Area

The red cells show 'occupied' cells and represent AOO. Area is given in km². The AOO calculation can be summarised in the following formula:

$$\text{AOO} = \text{number of occupied cells} * \text{area of individual cell}$$

AOO rating

As for EOO, the AOO rating is based on the values as listed under the IUCN Categories and Criteria Version 3.1 (IUCN, 2001). The area value for AOO is compared with the thresholds set in the Criterion B2 and the relevant rating is returned. The threshold values are as follows:

AOO (km²)	Rating
>10	CRITICALLY ENDANGERED
>500	ENDANGERED
>2,000	VULNERABLE
>4,500	NEAR THREATENED

Again, the threshold for Near Threatened is based on the relationship between the AOO values for CR, EN and VU.

AOO Subpopulations (Grid Adjacency)

Grid adjacency is one of two techniques used to define subpopulations. All contiguous grid cells from the AOO calculations are considered to be one subpopulation. The count of subpopulations is returned.

AOO Density

The AOO density value is a measure to describe the density of the point distribution. The value is calculated as the number of AOO subpopulations divided by the number of AOO cells. A value between 0 and 1 is returned where 0 is sparsely occupied i.e. all AOO cells are isolated and 1 is densely occupied i.e. all cells are contiguous.

$$\text{AOO Density} = 1 - (\text{AOO Subpopulations} / \text{AOO Number of cells})$$

Rapoport Area

The area represented by the Rapoport subpopulations, i.e. within the solid blue line, can be used as an additional measure of the species range. The area is measured in kilometres squared.

Rapoport Subpopulations

The second method for estimating subpopulations is Rapoport's mean propinquity method (Willis et al. 2003, Rapoport 1982). This technique is based on the mean line length of a minimum spanning tree (MST), which is a set of lines that connects all points in the minimum possible distance. The MST is represented by the blue dashed line on species maps. Subpopulations are defined when the limb (line) distance is greater than twice the mean limb distance (Willis et al. 2003). The solid blue line is a buffer around all lines in the MST that are \leq twice the mean line length. The buffer distance is the mean line length from the MST. Isolated points are also buffered to the mean line length from the MST.

Preliminary IUCN assessment - Batch

The result of the batch analysis is a dbf table that is automatically added to your project, as well as being saved in the location chosen by the user. The table below shows the field headings and what they refer to.

Field Name	Description
ID	Unique ID number for each species
UNIQUE_NAM	Name based on unique field e.g. species name
FILE_NAME	File name and path for exported map
NO_COL	Number of Collections
NO_LOC	Number of Localities
EOO	EOO (Extent of Occurrence)
EOO_RATING	EOO Rating
AOO_WIDTH	AOO (Area of Occupancy) Cell width/height (km)
AOO_CELL	AOO Number of Cells
AOO	AOO in km ²
AOO_SUB	AOO Subpopulations (Grid Adjacency)
AOO_DEN	AOO Density
AOO_RAT	AOO Rating
U_AOO_WIDT	As above, but with user defined grid cell size
U_AOO_CELL	As above, but with user defined grid cell size
U_AOO	As above, but with user defined grid cell size
U_AOO_SUB	As above, but with user defined grid cell size
U_AOO_DEN	As above, but with user defined grid cell size
U_AOO_RAT	As above, but with user defined grid cell size
RAP_AREA	Rapoport's Area km ²
RAP_NO_SUB	Rapoport's Subpopulations
MAX_DIAM	EOO Max Diameter (km)
DATE	Date of analysis

Discussion of the measures used:

The conservation ratings given here, although calculated based on IUCN categories and criteria, are not equivalent to full IUCN ratings submissible for the Red List. The majority of measures presented here relate to geometry and species range measures which focus on just one aspect of threat considered in the IUCN categories and criteria.

However, the measures calculated do provide a good initial estimate of threat and can be used as a baseline for more detailed assessments that can incorporate population data, literature research, further GIS analysis and consultation of experts/specialists.

Cases of vagrancy, georeferencing and error checking

Care must be taken when adding data to be analysed. Outlying points or cases of vagrancy should be excluded and georeferencing must be error checked. Many tools and methods now exist to aid georeferencing and to describe errors or georeference uncertainty. See Wieczorek et al (2004) and the following links for details:

<http://bg.berkeley.edu/latest/>

<http://manisnet.org/GeorefGuide.html>

<http://www.gbif.org/prog/digit/Georeferencing>

<http://www.museum.tulane.edu/geolocate/default.aspx>

<http://www.diva-gis.org/>

Severely fragmented

The AOO Density measure can be used as an indication of a fragmented distribution, although will not be enough to qualify a species under the IUCN 'severely fragmented' sub criterion. In order to qualify, a detailed understanding of area of occupancy, dispersal ability and average population density is now required. It is hoped a new model for severely fragmented can be incorporated into future updates of this extension.

VU D2

As well as the B criterion the AOO measure can also be applied to the D criterion under Vulnerable (VU) D2. If AOO is restricted such that the population is prone to the effects of human activities or stochastic events and may become Critically Endangered or Extinct in a short time period then VU D2 may be appropriate. However, although a guideline threshold of 20km² is suggested by IUCN this is not intended to be literal and therefore it is not reported in the Preliminary IUCN results created by this tool.

EOO

The IUCN Guidelines document (version 6.2) provides useful discussion of the problems associated with estimating EOO. The convex hull, as used here, has previously been criticised due to the coarse level of resolution on its outer surface (Ostro et al. 1999). However, the convex hull is still considered a useful approximation of EOO as the purpose of EOO is to measure the

degree to which risks from threatening factors are spread spatially across the taxon's geographical range.

When EOO is applied to criteria other than B1, such as reductions (criterion A) or continuing declines (B and C), then the convex hull may no longer be the most appropriate measure as it is sensitive to outliers and sampling effort. An alpha hull may be more appropriate in this situation (Burgman and Fox, 2003).

Additional measures proposed to delimit ranges include kernel estimators and variations on the convex hull, e.g. the local nearest neighbour convex hull (Getz and Wilmers 2004 - <http://nature.berkeley.edu/~alyons/locoh/>).

AOO

The problems associated with scale and AOO measurements are well described in the IUCN guidelines. The tools in this extension allow the user to define a grid cell length. In addition a sliding scale grid cell width is suggested which is scaled to the EOO measurement. The IUCN recommended scale of a 2 x 2 km grid (4 km²) can be applied but may not be appropriate if the point distribution does not fully represent occupied areas. In this case the assumption will be that areas without points are confirmed absences whereas this may simply be an artefact of collection effort.

The approach described above is deemed suitable for a preliminary assessment, but for a full assessment it is advised that the AOO measure is more carefully defined e.g. by using habitat maps derived from remote sensing imagery or range prediction models. The IUCN guidelines document (Version 6.2) should be consulted when using habitat maps as estimates for AOO.

Future developments

The tool presented here is in the process of being re-written for use in ArcGIS. Further improvements to the tool will be included in future releases.

References:

Burgman, M. A. and J. C. Fox. 2003. Bias in species range estimates from minimum convex polygons: implications for conservation and options for improved planning. *Animal Conservation* **6**: 19–28.

Getz, W. and C. Wilmers. 2004. A local nearest-neighbor convex-hull construction of home ranges and utilization distributions. *Ecography* **27**: 489-505

IUCN 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Ostro, L. E. T., T. P. Young, S. C. Silver,, F. W Koontz. 1999. A geographic information system method for estimating home range size. *Journal of Wildlife Management* **63**: 748-755.

Rapoport E.H. 1982. *Areography: Geographical Strategies of Species*. Pergamon Press, New York.

Schatz, G. 2002. Taxonomy and Herbaria in Service of Plant Conservation: Lessons from Madagascar's Endemic Families. *Annals of the Missouri Botanic Garden* **89**(2): 145-152.

Wieczorek, J., Q. Guo, and R. Hijmans. 2004. The point-radius method for georeferencing locality descriptions and calculating associated uncertainty. *International Journal of Geographical Information Science*. **18**:745-767.

Willis, F., Moat, J. and Paton, A. 2003. Defining a role for herbarium data in Red List assessments: a case study of *Plectranthus* from eastern and southern tropical Africa. *Biodiversity and Conservation* **12**: 1537-1552.