# USING SPATIAL INFORMATION TO SUPPORT DECISIONS ON SAFEGUARDS AND MULTIPLE BENEFITS FOR REDD+



STEP-BY-STEP TUTORIAL V1.0: EXTRACTING AND PROCESSING IUCN RED LIST SPECIES DATA USING A RASTER METHOD USING ARCGIS 10.3



The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and UN Environment.

The UN Environment World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of UN Environment, the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 35 years, combining scientific research with practical policy advice.

#### Prepared by Corinna Ravilious and Simon Blyth

#### Copyright: 2017 United Nations Environment Programme

**Copyright release:** This publication may be reproduced for educational or non-profit purposes without special permission, provided acknowledgement to the source is made. Re-use of any figures is subject to permission from the original rights holders. No use of this publication may be made for resale or any other commercial purpose without permission in writing from UN Environment. Applications for permission, with a statement of purpose and extent of reproduction, should be sent to the Director, UNEP-WCMC, 219 Huntingdon Road, Cambridge, CB3 ODL, UK.

**Disclaimer:** The contents of this report do not necessarily reflect the views or policies of UN Environment, contributory organisations or editors. The designations employed and the presentations of material in this report do not imply the expression of any opinion whatsoever on the part of UN Environment or contributory organisations, editors or publishers concerning the legal status of any country, territory, city area or its authorities, or concerning the delimitation of its frontiers or boundaries or the designation of its name, frontiers or boundaries. The mention of a commercial entity or product in this publication does not imply endorsement by UN environment.

We welcome comments on any errors or issues. Should readers wish to comment on this document, they are encouraged to get in touch via: <u>ccb@unep-wcmc.org</u>.

**Citation:** Ravilious, C. and Blyth, S. (2017) Using spatial information to support decisions on safeguards and multiple benefits for REDD+. Step-by-step tutorial v1.0: Extracting and processing IUCN Red List Species data using a raster method using ArcGIS 10.3. Prepared on behalf of the UN-REDD Programme. UNEP World Conservation Monitoring Centre, Cambridge, UK.

Acknowledgements: With thanks to support provided by IUCN Species Programme.

These training materials have been produced from materials developed for working sessions held in various countries, to aid the production of maps using open-source GIS software to inform REDD+ planning and safeguards policies.





## Contents

<b>1.</b> I	ntroduction1
1.1.	About this tutorial1
1.2.	Example species richness maps from Panama and Kenya3
2. L	Ising IUCN Red List species data and generating species richness maps5
2.1.	Selecting and downloading species data from the IUCN Red List website5
2.1.1	. Searching for non-spatial data5
2.1.2	. Save the search and exporting to CSV format6
2.1.3	. Download the IUCN Red List spatial data layers9
2.2.	Vector spatial data selection and preparation10
2.2.1	. Format species CSV file in preparation for querying the spatial data10
2.3.	Setting up a relate between the species table and the spatial dataset
2.1.	Using the relate to select the species polygons for species present in the table14
2.1.1	. From the previous selection select out the current native species range17
2.1.2	. From the previous selection select out only terrestrial species ranges
2.2.	Instructions for adding the ExploringMultipleBenefits ArcGIS toolbox to ArcMap18
2.3.	Running the species richness models in the Exploring multiple benefits toolbox20
2.3.1	. Creating a snapraster21
2.3.2	. Split the species data into individual species files22
2.3.3	. Create Boolean species rasters25
2.3.4	. Check to see if any of the Boolean Rasters are empty26
2.3.5	. Convert no data to 0 in Boolean Rasters27
2.3.6	. Sum the raster to create a species richness dataset

## **1. Introduction**

#### **1.1.** About this tutorial

REDD+ is a voluntary climate change mitigation approach that has been developed by Parties to the UNFCCC. It aims to incentivize developing countries to reduce emissions from deforestation and forest degradation, conserve forest carbon stocks, sustainably manage forests and enhance forest carbon stocks. This will involve changing the ways in which forests are used and managed, and may require many different actions, such as protecting forests from fire or illegal logging, or rehabilitating degraded forest areas.

REDD+ has the potential to deliver multiple benefits beyond carbon. For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation, erosion control and non-timber forest products (NTFPs). Some of the potential benefits from REDD+, such as biodiversity conservation, can be enhanced through identifying areas where REDD+ actions might have the greatest impact using spatial analysis and other approaches. To understand this, it helps to know where species are likely to be present.

The purpose of this tutorial series is to help participants in technical working sessions, who are already skilled in GIS, to undertake analyses that are relevant to REDD+. The tutorials have been used to build capacity in a number of countries to produce datasets and maps relevant to their spatial planning for REDD+, and to develop such map products. Maps developed using these approaches appear in a number of publications whose aim is to support planning of strategy options that enhance biodiversity and ecosystem services as well as delivering climate change mitigation (see <a href="http://bit.ly/mbs-redd">http://bit.ly/mbs-redd</a> for country materials). There is of course no requirement for countries to use the approaches described in these tutorials.

Where countries have identified biodiversity conservation as a goal for REDD+, and to be consistent with the Cancun safeguards for REDD+ on protecting biodiversity, it is useful to identify areas where specific REDD+ actions are feasible and can protect threatened species. It may also be useful to identify areas outside forest where threatened species may be vulnerable to the displacement of land-use change pressures or to afforestation.

This tutorial demonstrates how a species richness grid can be created using species range data from the IUCN Red List (IUCN, 2013). It provides full instructions on how to select, analyze and export information from the non-spatial species data on the IUCN Red List website and how to further analyze the information along- side the IUCN spatial data using ArcGIS 10.x. A similar tutorial that uses QGIS as an open-source alternative platform is available from <a href="http://bit.ly/GIStools-redd">http://bit.ly/GIStools-redd</a>:

Ravilious, C. (2015) Using spatial information to support decisions on safeguards and multiple benefits for REDD+. Step-by-step tutorial v1.1: Extracting and processing IUCN Red List species data using a raster method in QGIS 2.8. Prepared on behalf of the UN-REDD Programme. UNEP World Conservation Monitoring Centre, Cambridge, UK.

Please note that the range data represent areas of occurrence rather than areas of occupancy. That is, there are areas within each range where the species is likely not to be present. For this and other reasons, protecting only a small part of the range may not be sufficient to ensure that a species is protected. Whilst this tutorial uses extent of occurrence data from the global IUCN dataset, the same methods can be used with other national-level data where it is available.

#### 1.2. Example species richness maps from Panama and Kenya

In both examples, biomass carbon is contrasted with species richness using a matrix legend. A matrix legend tutorial is also available at <u>http://bit.ly/GIStools-redd</u>.



Source: Kapos, V., Walcott, J., Thorley, J., Mariscal, E., Labbate, G., Ravilious, C., Miles, L., Narloch, N., Trumper, K. and Bertzky, M. (2015) Planning for REDD+ in Panama: securing social and environmental benefits. Cambridge, UK: UNEP-WCMC. <u>http://bit.ly/panama-redd</u>

Map 6: How are biomass carbon stocks distributed in relation to the ranges of threatened species and protected areas? This map shows the distribution of biomass carbon stocks and threatened species richness in Kenya. The dark red areas have the highest density of both biomass carbon and threatened species, notably the five water towers (see Map 10). Pink areas have high threatened species richness and low carbon stocks.



#### Methods and data sources:

Biomass carbon (left): Baccini, A., Goetz, S., Walker, W., Laporte, N., Sun, M., Sulla-Menashe, D., Hackler, J., Beck, P., Dubayah, R., Friedl, M. (2012) Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Climate Change 2. 3:182-185. http://dx.doi.org/10.1038/NCLIMATE1354, The Woods Hole Research Center. National dataset of Aboveground Live Woody Biomass density at spatial resolution of circa 500m derived from field/LiDAR(GLAS)/MODIS. Ecosystem-specific conversion factors (IPCC 2006) were used to add below-ground biomass

carbon to this map. Species richness: Derived from the ranges of mammal, bird, reptile and amphibian species classified as 'Critically Endangered', 'Endangered', and 'Vulnerable' by the IUCN Red List of Threatened Species (2014) Version 2014.2 http://www.iucnredlist.org. Downloaded Nov 2014.

Protected areas: IUCN and UNEP-WCMC (2014), The World Database on Protected Areas (WDPA) [On-line]. Cambridge, UK: UNEP-WCMC. Available at:

www.protectedplanet.net Accessed 12/2014. Additional information from the Kenya Forest Service (KFS) was used to supplement this data. National parks and reserves are labeled on this map.

Source: Maukonen, P., Runsten, L., Thorley, J., Gichu, A., Akombo, R. and Miles, L. (2016). Mapping to support land-use planning for REDD+ in Kenya: securing additional benefits. Prepared on behalf of the UN-REDD Programme, Cambridge, UK: UNEP-WCMC. <u>http://bit.ly/kenya-redd</u>

## 2. Using IUCN Red List species data and generating species richness maps

## 2.1. Selecting and downloading species data from the IUCN Red List website

The IUCN Red List of Threatened Species website allows users to search for and extract tabular information (in comma separated values (CSV) file format) on the status of threatened species. The website provides a user friendly interface and gives the user flexibility to customize searches based on a range of criteria. Users must register with the website to save and export customized searches.

## 2.1.1. Searching for non-spatial data

Open a web browser and go to the IUCN Red List website at http://www.iucnredlist.org/.

This search below is an EXAMPLE search for Mammals with threat status of Critically Endangered (CR) and Endangered (EN).



i. Next Click on Assessment-Search the IUCN Red List Clear all criteria Untick categories not required j. Your Search Criteria Publication Years EX - Extinct d Categ i.e. in this example **unticking** Vulnerable 1 – Lower Risk: Co **EX and EW** and keeping the rest. 2004 or LR/nt – Near ) – Data Deficien or LR/Ic – Least Assessme 2006 2008
 2009
 2010
 2011
 2012
 2013
 2014 k. Press the arrow key to send the Inder petition updating (older than 10 selection across to the Your Search 2007 Criteria panel Click Run search Ι.

This search will result in a list of species within the AMPHIBIA, AVES and MAMMALIA taxonomic groups that have critically endangered, Endangered, Vulnerable, Lower Risk: Conservation Dependent, Near Threatened, Data Deficient or Least Concern Red List status. The search will produce in a list of species containing and additional attribute data, including the threat status of each of the species.

There are other criteria that you may want to include. For example, to limit the search to species dependent upon a particular habitat type you would click on Habitat, expand and tick the relevant habitat type and send that across to the search criteria panel.



## 2.1.2. Save the search and exporting to CSV format

User Information       The first time new users export a search they are required to fill out some inform about themselves and the intended use the data         We agree to respect your privacy. Please see our privacy policy.       First name:         First name:	<b>\</b>		
We agree to respect your privacy. Please see our <u>privacy policy</u> .         First name:         Last name:         Mailing address:         (optional)         Phone number:         (optional)         Country of residence:         Image: Please select a country:)         (no permanent residence)         Afghanistan         Algeria         (Inf: On many browsers, press the first letter of your country name to jump in the list.)	User Informati	on	
First name: Last name: Mailing address: (optional) Phone number: (optional) Country of residence: (Please select a country:) (no permanent residence) Afghanistan Albania Algeria (Hin: On many browsers, press the first letter of your country name to jump in the list.) the data Click on Supply your information and fill in the requested det Click on Supply in the list.)			
Last name: Mailing address: (optional) Phone number: (optional) Country of residence: (hir: on mary browsers, press the first letter of your country name to jump in the list.) Click on Supply your information and fill in the requested det Click on Supply in the list.)	First name:		
(optional) Phone number: (optional) Country of residence: (Please select a country:) (no permanent residence) Adjanaistan Albania Algeria (Hint: On many browsers, press the first letter of your country name to jump in the list.) Click on Supply your (Click on Supply) (Click on Supp	Last name:		
(optional) Country of residence: Afghanistan Albania Algeria (Hini: On many browsers, press the first letter of your country name to jump in the list.) Click on Supply your information and fill in the requested def Click on Supply in the list.			
(Please select a country:) (no permanent residence) Afghanistan Albania Algeria (Hint: On many browsers, press the first letter of your country name to jump in the list.)			Click on Supply your
(Hint: On many browsers, press the first letter of your country name to jump in the list.)		(no permanent residence) E Afghanistan Albania	<b>information</b> and fill in the requested deta
Aunauon. (Please select a sector:) 💌	Affliction	(Hint: On many browsers, press the first letter of your country name to jump in the list.)	Click on <b>Submit</b>
Please indicate how you intend to use the exported IUCN Red List data:			



		Saved Searches
h.	Click on the <b>saved search</b> e.g. <b>NGA_AmpAveMam</b> in <u>this</u> example	Saved searches are permanently stored in your user account. Once a search is saved, you may also export the results for offline use, or provide a link for others to access your saved search.  • NGA_AmpAveMam  • Ind your current search

Export Results	i.	Scroll down to Export results
To download the results of your search, use the button below. Your search results will be exported to common downloadable formats.		and click on <b>Export results</b>

Saved Searches	The dataset will then give a status of Quand for export
Saved searches are permanently stored in your user account. Once a search is saved, you may also export the results for offline use, or provide a link for others to access your saved search.	status of Queued for export.
Gueued for export     Add your current search	
ed Searches	

j. Refresh the browser to see the status change to show the export is complete or if it is taking a long time log out and once the email has been received, log back in to the Red List website and click on the My Downloads Tab to get back to your saved searches.

	The IUCN Red List of Threatened Specie	es™ 2014.	.2 🕅	(Downloads   ) AQ   Contact   Terms of use   IUCN.org
C RED	About Initiatives News Photos Pa	artners ::Spons	ors ::Reso	
Guiding Conservation for 50 Years	Enter Red List search term(s)	SEARCH OPTIONS	Discover more	Mowe -
	stored in your user account. Once a search is sav lline use, or provide a link for others to access you		k.	Click on the <b>exported search</b>
NGA AmpAveMam	ober 2014			e.g. <b>NGA_AmpAveMam</b> in the example
to return to it later.	our current search. Please save your search if you may wish	l. m.		down to the Export results on Comma-Separated Values ((
Load this search Permalink To allow others to view your search http://www.iucnredlist.org/apps/re	h results, you may copy and distribute the following link: dist/searchamt/4eb90157-b44da210	n.	If the o gener	ne zip file will download download has placed the file ir al download folder move the z
Export Results Your search results have been ex your preferred format(s). Comma-Separated Values	ported. Please use the links below to download the export in	о.	projec	a more suitable location e.g. i t folder <b>ne</b> the zip file to somthing sens
	ge <u>(XML)</u> a may change over time. The exported data is current as of a latest data, use the button below; your exported data will be ta.	p.	exam	GA_AmpAveMam.zip in this ple click on zip folder, extract the
Delete Search This search is saved to your save Delete search	l searches as "mam_cr_en".		file	
		— q.	Renan	<b>ne</b> the csv file e.g.

NGA\_AmpAveMam.csv in this example

#### 2.1.3. Download the IUCN Red List spatial data layers

The next steps are for downloading spatial data. It is only possible to download the whole global dataset. It is not possible to filter by county prior to download. Please note that some of the spatial datasets are very large.

If you have received the spatial data directly from IUCN you can skip this section.

a. Open a web browser and go to the IUCN Red List website at

b. From the Resources tab, click on Spatial Data Download

	The IUCN Red List of Threatened Species™ 2014.2 About ∷Initiatives ∷News ∷Photos ∷Partners ∷Sponsors	<u>My Downloads   FAQ   Cor</u> ::Resources
Guiding Conservation for 50 Years	Enter Red List search term(s) GO OTHER SEARCH OPTIONS Discove	Key Documents Cytegories and Criteria Classification Schemes
Home » Reso	urces » Spatial Data Download	Data Prganization
	Spatial Data Download	Information Sources and Quality
Resources		Assessment Process
Resources	Red List Spatial Data	Red List Training
Key Documents		References
Categories and Criteria	The IUCN Red List of Threatened Species contains assessments for just over	Acknowledgements
<b>Classification Scheme</b>	SIS News and Updates	
Data Organization	d within the	
Spatial Data Download	parental species. The data is available as ESRI shapefiles format and contain range of each species. Ranges are depicted as polygons. DBF files accompa	
Information Sources a Quality		

#### c. Scroll down on the Spatial Data page to the Datasets table

Cnatial	Data	Download
Spallar	Data	Download

	Spatial Data DO	WIIIOad							
Resources	Red List Spatia	Data							
Key Documents	Red List Spatia	li Data							
Categories and Criteria			ements for just over 73,000 species,						
Classification Schemes		ds have spatial data. This spatial da sed taxonomic groups. It is importa							
Data Organization	as those listed as Data	Deficient are not mapped and subs	pecies are mapped within the						
Spatial Data Download		lata is available as ESRI shapefiles Ranges are depicted as polygons.							
Information Sources and Quality		distribution status, sources and oth							
Assessment Process	Please note that the file	as are large and download times cou	uld be quite lengthy. The Taxonomy						
Red List Training		g higher taxonomy and species							
References	the spatialization of the spatialization of the spatial spatial of the spatial								
Acknowledgements	beginning included with	in parental species polygons.							
SIS News and Updates	For ease of distribution	and downloading, the data is divide	d by taxonomic groups.						
	More information about	spatial data, please contact the <u>IUC</u> <u>Spatial data resources here</u> , as page will be available shortly. Specific Group(s)	Descriptions and species lists						
	Main Dataset	Specific Group(s)	Descriptions and species lists						
	C	Marine Mammals	Includes mammal families for seals, sea lions and walrus, whales, dolphins and porpoises, manatees and dugongs.						
	Mammals 生	Terrestrial Mammals	Excludes mammal families for seals, sea lions and walrus, whales, dolphins						
		57	and porpoises, manatees and dugongs.						
		Taxonomy Table	Species list from website						
		Tailless Amphibians	Species from the order Anura as a shapefile.						
	Amphibians 보	Tailed Amphibians	Species from the order <u>Caudata</u> as a shapefile.						
	Amphibians C	Caecilian Amphibians	Species from the order Gymnophiona shapefile.						
		Taxonomy Table	Species list from website						
	Birds		BirdLife International is the IUCN Red Listing Authority for birds and maintains the most up to date information on global bird distributions. To request a copy of the shapefiles of species range maps for threatened birds, please visit the BirdLife Data Zone <u>here</u> .						

http://www.iucnredlist.org/

- d. Click the links to navigate to each dataset and download the following global datasets:
  - > Mammals
  - > Amphibians
  - Birds (via the link to the BirdLife Data Zone)

(Leave Reptiles for now as assessment is not yet complete for all species)

*These files are all stored in geographic coordinate system (EPSG: 4326). Be aware these large files will take some time to download.* 

Note: If you have received the spatial data directly from IUCN, this may be a single geodatabase containing all taxa in a single feature class rather than as separate files.

#### 2.2. Vector spatial data selection and preparation

The next section we will use a CSV file extracted from the IUCN RedList web search for Critically Endangered, Endangered and Vulnerable birds, mammals, amphibians and reptiles in Colombia.

#### 2.2.1. Format species CSV file in preparation for querying the spatial data

a. Open the 'exported search' results csv file (that was downloaded in section 2.3 step m) e.g.
 COL\_CRENVU.csv in this example. Open the file Excel.

Colombia_la.dbf	K	Move to Quarantine	1	29/02/2016 14:58
rl2.dbf		Open with	×≣	Excel (desktop)
col_crenvu.shp.WCM		open with	<u>^</u>	Excel (desktop)
col_crenvu.shp.WCM		Restore previous versions		Notepad
col_crenvu_POselection		Send to +		WordPad
col_crenvu_POselectio		Cut		Choose default program
Colombia_la.shp.WCM				14/06/2016 13:47
Colombia_la.shp.WCM		Сору	ι.	27/06/2016 11:14
rl2.dbf.WCMC-LT-019		Create shortcut	ι.	14/06/2016 13:47
rl2.dbf.WCMC-LT-019		Delete	ι.	27/06/2016 11:14
snapgrid.vat.WCMC-l		Rename	ι.	14/06/2016 13:47
snapgrid.vat.WCMC-l		Properties	ι.	27/06/2016 11:14
COL_CRENVU.csv	_	rioperaes	1	24/02/2016 18:11

#### A raster method for IUCN Red List data processing in ArcGIS 10.3

🚺 🗄 🗲 e	~ <b>\$</b>						CO	L_CRENVU.cs	sv - Excel								?	图 -	
FILE HOME	INSERT PAGE	E LAYOUT FOR	ULAS DA	TA REVI	EW VIE	V INQU	IRE Ad	robat P	OWERPIVOT								Corini	na Ravilio	us + O
Paste Clipboard	Calibri B I U	- 11 - A A - A		■	Wrap Wrap	& Center 🔹		 %	.00 Cond	,	ormat as Cel Table - Styles yles		Delete Form	🗄 🗖 Eill		Sort & Find &			
Cipboard	191	Font	Ga I	Aligh	ment		31 I	umber	Car I	50	yies		Cells		Editi	ng			
Q1 * :	$\times$ $f_{i}$	com_spa																	
				6										0			-		
1 Species ID Kin	6 C	Class Srder	Family	G Genus	H Species	1 Authority	J Infr. rank	K Infr. name	L Infr. outb	M Stk cuk	N pc Synonym	0	P com fro	Q com cno	к rl status	5 rl critoria	rl version ve	0	v
	IMALIA CHORDAT.			Agalychni		(Boulenge			auco	SUK_SUL		t Lemur Le			CR	A4ace	3.1	_	decrea
	IMALIA CHORDAT		NIARDEIDAI		agami	(Gmelin, 1						Agami He			VU	A3c	3.1		unkno
4 55099 AN	IMALIA CHORDAT			Allobates	juanii	(Morales,	, 1994)				Colosteth	ius juanii	Colostethu	us juanii	CR	B2ab(i,iii)	3.1	2004	decrea
5 55141 AN	IMALIA CHORDAT	AMPHIBIA ANURA	AROMOB	Allobates	ranoides	(Boulenge	r, 1918)				Colosteth	us ranoid	es  Coloste	thus ranoi	EN	B1ab(i,ii,ii	3.1	2010	decrea
6 55166 AN	IMALIA CHORDAT	AMPHIBIA ANURA	AROMOB	Allobates	wayuu	(Acosta, Ci	uentas &	Coloma, 19	99)		Colosteth	nus wayuu			VU	D2	3.1	2004	unkno
7 22687614 AN	IMALIA CHORDAT	AVES CAPRI	<b>UUTROCHILI</b>	Amazilia	castaneive	Gould, 185	6					Chestnut	-bellied Hu	Amazilia \	EN	B1ab(iii)	3.1	2012	decrea
8 55224 AN	IMALIA CHORDAT	AMPHIBIA ANURA	DENDROE	Ameerega	ingeri	(Cochran a	nd Goin,	1970)			Epipedob	ates inger	ri		CR	B1ab(iii)	3.1	2004	decrea
9 178660 AN	IMALIA CHORDAT	REPTILIA SQUAR										Ruthven'	s Anadia		VU	B1ab(iii)	3.1	2010	unkno
10 55171 AN	IMALIA CHORDAT	AMPHIBIA ANURA		Andinoba							Dendroba	ates altobu	ueyensis  R	anitomeya	VU	D2	3.1	2004	stable
11 55177 AN	IMALIA CHORDAT	AMPHIBIA ANURA	DENDROE	Andinoba	bombetes	(Myers & E	aly, 1980	)			Dendroba	a Cauca Po	ison Frog		EN	B1ab(iii)	3.1		decrea
						(*) * *	1.1	n 1 nf 1			~ • •	1.11	1.10		• • • •		~ *		

b. Scroll along the column headings of the table. Some will need to be changed as GIS software such as ArcGIS will not accept them. Change the ones listed below in red

OLD Field Name		New Field Name
Species ID	=	New Field Name Species_ID Kingdom
Kingdom	=	Kingdom
Phylum	=	Phylum
Class	=	Class
Order	=	Order
Family	=	Family
Genus	=	Genus
Species	=	Species
Binomial	=	Binomial
Authority	=	Authority
Infraspecific rank	=	Inf_rank
Infraspecific name	=	Inf_name
Infraspecific authority	=	inf_auth
Stock/subpopulation	=	stk_subpop
Synonyms	=	Synonyms
Common names (Eng)	=	com_eng
Common names (Fre)	=	com_fre
Common names (Spa)	=	com_spa
Red List status	=	rl_status
Red List criteria	=	rl_criteria
Red List criteria version	=	rl_version
Year assessed	=	year_ass
Population trend	=	poptrend
Petitioned	=	Petitioned

c. Click File>>Save to save the file (save the file as a .xls.

#### 2.3. Setting up a relate between the species table and the spatial dataset

This section prepares the spatial data ready for analysis. The IUCN spatial dataset is a complex dataset as it contains many overlapping polygons for each species for the entire world. Even sub setting the dataset for your area of interest can be problematic so these set of instructions are important steps to make sure the analysis runs as smoothly as possible and to reduce the risk of errors in processing.

- a. Open ArcGIS
- **b.** Add in the **IUCN Species spatial dataset(s)** (the data are in geographic coordinate system (i.e. WGS84)
- c. Untick the dataset in the table of contents to stop it drawing
- d. Add in a polygon dataset of the area of interest (e.g. country boundary). e.g. in this example Colombia\_la.shp.

Make sure the area of interest dataset is in the coordinate system you want to run the analysis in (i.e. in this example Lambert Azimuthal Equal Area)

- e. Click on the IUCN spatial dataset in the table of contents to make it the active layer e.g. iucn\_rl\_2014\_3\_w\_FW
- f. Add your geodatabase file (or shapefiles) of the species EOO polygons to ArcMAp
- g. Next add the ,xls file containing the species of interest (In this example COL CRENVU.xlsx)
- h. Click Add and the individual sheets within the excel file are listed

- i. Select the sheet containing the Red List data (in this example we sheet Red\_List\_Data).
- j. Click Add that sheet to ArcMap.



Export.

Export

k. Right-click on the sheet just added to ArcMap and click Open

١

□ □ D:\IUCN_Redlist\COL			4					
l	Joins K Rem Data Edit	Open this table. Sho double-click table r			Find and Replace Select By Attributes Clear Selection Switch Selection Select All Add Field Turn All Fields On Show Field Aliases		Class IPHIBIA (ES IPHIBIA IPHIBIA (ES IPHIBIA IPHIBIA IPHIBIA	AR AR AR TR( DEI GY DEI
ŧ	Disp	code Addresses lay Route Events lay XY Data perties		- <b>1</b> 11 - 2 - 2	Arrange Tables Restore Default Column Widths Restore Default Field Order Joins and Relates Related Tables Create Graph Add Table to Layout Reload Cache Print	•	IPHIBIA IPHIBIA IPHIBIA IPHIBIA IPHIBIA It of 418	DEI DEI DEI

- I. Click on the menu in the top left corner of the attribute table to get the **Table Options** menu
- m. Click Export

Export Data	<b>n.</b> Click on the <b>Browse</b> button to navigate to an output folder
Use the same coordinate system as: this layer's source data the data frame the feature dataset you export the data into (only applies if you export to a feature dataset in a geodatabase) Output table: D:\IUCN_Redlist\rl2.dbf	Name: rl2.dbf Save as type: dBASE Table O. Change Save as type to dBASE table
	<ul> <li>p. Give the dbf a name (in this example rl2.dbf)</li> <li>q. Click Save, then click OK</li> <li>r. Click Yes to add the file to the ArcMap Session</li> </ul>

r. Right click on your .dbf file i.e. in the example rl2.dbf and click Joins and Relates>>Relate.



In the relate window it is important to choose fields which relate the Red List species polygons and the .dbf file containing the species of interest list together, i.e. a common field to link both together. They do not necessarily have to have the same name but the information inside the field has to be common.

- s. The Field in this layer that the relate will be based on is the field in the dbf file to use to join the table to the spatial data so in this example we will use Species\_ID.
- t. The table or layer to relate ' this layer is the IUCN Red List spatial data polygon file (e.g. in this example iucn\_rl\_2014\_3\_w\_FW)

Relate	×
Relate lets you associate data with this layer. The associated da appended into this layer's attribute table like it is in a Join. Instea can access the related data when you work with this layer's attri vice-versa.	d you
Establishing a relate is particularly useful if there is a 1+to-many o many-to-many association between the layer and the related dat	
1. Choose the field in this layer that the relate will be based on:	
Species_ID	
2. Choose the table or layer to relate to this layer, or load from dis	sk:
iucn_rl_2014_3_w_FW	
3. Choose the field in the related table or layer to base the relate	on:
(id_no) ▼	
4. Choose a name for the relate:	
Relate add to rl2 to global gis file	
About relating data OK Car	ncel

- **u.** The field in the related table or layer to base the relate on is the field in the spatial dataset which relates to the field in the .dbf table (in example id\_no)
- v. Give the relate an appropriate name so it is clear what is the relate is representing
- w. Click OK

NOTE: Joining using Species\_ID and id\_no is more reliable than using the text field 'binomial'. Binomial can be used but is slower and due to there being some minor spelling inconsistencies between tables, and is therefore less likely to be able to join as many features correctly.

- 2.1. Using the relate to select the species polygons for species present in the table
- a. Right click on your dbf file and click Open (e.g. in this example on rl2.dbf)
- b. From the table options menu Select all records

-	Find and Replace									
	Select By Attributes		m	Class	Order_	Family	Genus	Species	Binomial	
]	-		AT	AMPHIBIA	ANURA	HYLIDAE	Agalychnis	lemur	Agalychnis lemur	(Boulenger, 188
	Clear Selection		AT	AVES	PELECANIFORMES	ARDEIDAE	Agamia	agami	Agamia agami	(Gmelin, 1789)
1	Switch Selection		AT	AMPHIBIA	ANURA	AROMOBATIDAE	Allobates	juanii	Allobates juanii	(Morales, 1994
1	Select All		AT	AMPHIBIA	ANURA	AROMOBATIDAE	Allobates	ranoides	Allobates ranoides	(Boulenger, 19
	Sciect All		AT	AMPHIBIA	ANURA	AROMOBATIDAE	Allobates	wayuu	Allobates wayuu	(Acosta, Cuent
	Add Field	Select All		AVES	CAPRIMULGIFORMES	TROCHILIDAE	Amazilia	castaneiventris	Amazilia castaneiventris	Gould, 1856
1	Turn All Fields On			AMPHIBIA	ANURA	DENDROBATIDAE	Ameerega	ingeri	Ameerega ingeri	(Cochran and
		Select all record	s.	REPTILIA	SQUAMATA	GYMNOPHTHALMIDA	Anadia	pulchella	Anadia pulchella	Ruthven, 1926
	Show Field Aliases		AT	AMPHIBIA	ANURA	DENDROBATIDAE	Andinobates	altobueyensis	Andinobates altobueyensis	(Silverstone, 1
	Arrange Tables	•	AT	AMPHIBIA	ANURA	DENDROBATIDAE	Andinobates	bombetes	Andinobates bombetes	(Myers & Daly,
			AT	AMPHIBIA	ANURA	DENDROBATIDAE	Andinobates	daleswansoni	Andinobates daleswansoni	(Rueda-Almona
	Restore Default Colu	umn Widths	AT	AMPHIBIA	ANURA	DENDROBATIDAE	Andinobates	dorisswansonae	Andinobates dorisswansonae	(Rueda-Almona
	<b>Restore Default Field</b>	d Order	AT	AMPHIBIA	ANURA	DENDROBATIDAE	Andinobates	opisthomelas	Andinobates opisthomelas	(Boulenger, 18
	Joins and Relates Related Tables	•	-	f 418 Select		DENDROBATIONE	Andinabatan	talimanaia	Andicabatas talimansis	(Parcel Pautio

c. From the table menu click related tables and click on your relate, In this example Relate add to rl2 to global gis file: iucn\_rl\_2014\_3\_w\_FW

Table	1					
	- 🖶 - I 🔓 🌄 🗹 🐗 🗙					
A	Find and Replace					
	Select By Attributes	m	Class	Order_	Family	Genus
	Clear Selection	A		ANURA	HYLIDAE	Agalychnis
		)A	T AVES	PELECANIFORMES	ARDEIDAE	Agamia
5	Switch Selection	)A	T AMPHIBIA	ANURA	AROMOBATIDAE	Allobates
	Select All	)A	t amphibia	ANURA	AROMOBATIDAE	Allobates
		A	T AMPHIBIA	ANURA	AROMOBATIDAE	Allobates
	Add Field	A	T AVES	CAPRIMULGIFORMES	TROCHILIDAE	Amazilia
	Turn All Fields On	)A	t amphibia	ANURA	DENDROBATIDAE	Ameerega
	CL FLUXE	A	T REPTILIA	SQUAMATA	GYMNOPHTHALMIDA	Anadia
~	Show Field Aliases	)A	t amphibia	ANURA	DENDROBATIDAE	Andinobates
	Arrange Tables	)A	t amphibia	ANURA	DENDROBATIDAE	Andinobates
		A	t amphibia	ANURA	DENDROBATIDAE	Andinobates
	Restore Default Column Widths	A	t amphibia	ANURA	DENDROBATIDAE	Andinobates
	Restore Default Field Order	A	t amphibia	ANURA	DENDROBATIDAE	Andinobates
	Joins and Relates	•				Andinabatan
	Related Tables	•	Relate a	dd to rl2 to global gis	file : iucn_rl_2014_3_w	_FW
l dh	Create Graph			Diselara		. that

The species that were selected in your dbf file will be selected in the spatial dataset (i.e. in this case, the species polygons in **iucn\_rl\_2014\_3\_w\_FW**). This selection may take several minutes, depending both on 1) how many species are being selected, and 2) whether you are working on the hard drive of your local computer or working on a network drive. The selection when finished, will show how many polygons have matched the species table (in this instance 2,696 polygons).

JC	n_rl_2014_3_w_F	FW								
Τ	OBJECTID *	shape *	objectid_1	id_no	binomial	presence	origin	compiler	year	Τ
·	783	Polygon	73634	1807	Aotus griseimembra	1	1	IUCN	2008	8 1
I	784	Polygon	73635	1808	Aotus lemurinus	1	1	IUCN	2008	1
I	3574	Polygon	73638	2276	Ateles belzebuth	2	1	IUCN	2008	3
I	3575	Polygon	73639	2276	Ateles belzebuth	1	1	IUCN	2008	3
]	3576	Polygon	73646	2276	Ateles belzebuth	1	1	IUCN	2008	3
]	3577	Polygon	73676	2279	Ateles geoffroyi	1	1	IUCN	2008	3
I	3578	Polygon	74336	2279	Ateles geoffroyi	1	1	IUCN	2008	3
1	3579	Polygon	73678	2279	Ateles geoffroyi	1	1	IUCN	2008	3
1	3580	Polygon	73657	2279	Ateles geoffroyi	1	1	IUCN	2008	3
Ì	3581	Polygon	73688	2279	Ateles geoffroyi	1	1	IUCN	2008	3
1	3582	Polygon	73636	2279	Ateles geoffroyi	1	1	IUCN	2008	3
İ	3583	Polygon	73677	2279	Ateles geoffroyi	1	1	IUCN	2008	π
Ì	3637	Polygon	95892	2477	Balaenoptera musculus	1	1	IUCN	2012	1
1	0000	Delveen	05060	2477	Palaopantora musoulus	4	4	HON	2012	

NOTE: - If you are using a combined dataset of all species (mammal, birds, amphibians and reptiles all in a single shapefile or geodatabase), such a global dataset is very large. If processing data for a large number of species and at a global extent you may want to do some additional pre-processing steps to simplify the data first. UNEP-WCMC has developed a method to generate a simplified version of the global dataset - please contact UNEP-WCMC (<u>ccb@unep-wcmc.org</u>) for further information.

d. Return to the table of contents and right click on the species polygons dataset (i.e. in this example iucn\_rl\_2014\_3\_w\_FW), then click Data>>Export Data to export the selected species polygon records to a new shapefile or geodatabase

<ul> <li>□ D:\JUCN_Redlist\IU</li> <li>□ iucn_rl_2014_3;</li> <li>□ and the set of the</li></ul>	in E	Red_List_Received_May_2015\a Copy Remove Open Attribute Table Joins and Relates	•					<ul> <li>⇒ Exploringiviu</li> <li>⇒ Core Rast</li> <li>⇒ Generatin</li> <li>⇒ Generatin</li> <li>⇒ Check</li> <li>⇒ Step 1</li> <li>⇒ Step 2</li> </ul>
	Ŷ	Zoom To Layer			<b>-</b>	ž ×		
	ā?	Zoom To Make Visible						
		Visible Scale Range	•	ojectio	d_1	id_no	binomial	presence
		Use Symbol Levels			3634	1807	Aotus griseimembra	1
				<u> </u>	3635 3638	1808 2276	Aotus lemurinus Ateles belzebuth	2
		Selection	•		3639	2276	Ateles beizebuth	2
		Label Features		· ·	3646	2276	Ateles belzebuth	1
		Edit Features	•		3676		Ateles geoffroyi	1
		Convert Labels to Annotation			4336 3678	2279 2279	Ateles geoffroyi Ateles geoffroyi	1
	80	Convert Features to Graphics			3657	2279	Ateles geoffroyi	1
	90			7	3688	2279	Ateles geoffroyi	1
		Convert Symbology to Representation.	•	7	3636	2279	Ateles geoffroyi	1
		Data	•	13	Repai	ir Data So	purce	1
	$\diamond$	Save As Layer File		Q	Ехро	rt Data	, ,	1
	P	Create Layer Package			Ехрог	rt To CAE	)	
	er.	Properties			Make	e Perman	ent Export Data	
	-	[ldcl][l_2014]3[w]1W			View	Item Des	cription Save this layer's data as	
					Revie	w/Remat	or geodatabase feature	class
				100				

Saving Data

#### e. Save to a new shapefile e.g. in this example col crenvu.shp.

Export Data	Look in:	TUCN_Redlist	<b>√</b> 1	è 🏠 🗔	<b>*</b>	21   🖆	1 🗊 🚳
	Name		Туре				
Export: Selected features	SBA iuc	:n_rl_2014_3_w_FW_CO	Folder				
Use the same coordinate system as:	Colom	bia_la.shp	Shapefile				
this layer's source data	🖻 🖻 Red_Lis	t_Data.xlsx	Excel File				
◎ the data frame							
<ul> <li>the feature dataset you export the data into (only applies if you export to a feature dataset in a geodatabase)</li> </ul>	$\mathbb{N}$						
Output feature dass:							
D:\UCN_Redlist\col_orenvu.shp		<b>N</b>					
	Name:	col_crenvu.shp					Save
	Save as type	e: Shapefile			•	C	ancel
OK Cancel							
	A	rcMap				X	
	Г						

f. Click Save, then OK and click Yes to add the exported data to the ArcMap session.

g. Then go to the top of the screen

and from the Selection menu,

click Clear selected features, so

that you are no longer selecting

the records in the global dataset.

Q COL\_CRENVU.mxd - ArcMap File Edit View Bookmarks Insert Selection Geoprocessing Customize Select By Attributes... 🗋 🚰 🔚 🖨 I % 🗿 🖺 🗶 I 🄊 🤇 Select By Location... i 🔍 🔍 🥙 🥝 | 👯 🖓 | 🔶 🔶 | 🕅 -Select By Graphics 1 ÷ Zoom To Selected Features Table Of Contents s#1 Pan To Selected Features 🗞 📮 😞 📮 🗉 ∑ Statistics... 🖃  *Eayers* Clear Selected Features D:\IUCN\_Redlist 🗉 🗌 Colombia\_la Interactive Selection Method ٠ Selection Options...

Do you want to add the exported data to the map as a layer?

No

#### 2.1.1. From the previous selection select out the current native species range

- a. Right click on the newly added subset species layer e.g. col\_crenvu.shp in this example and and click Open attribute table.
- b. Click on the top left button and click Select by Attributes.

🔁 •   🏪 🎙	🛃 🛛 📲 🗙			
Find and Repl	ace			
Select By Attri	butes	d_1	id_no	
Clear Selection		'3634	1807	Aotus g
		mene	4808	Aotus le
Switch Selecti	Select By Attributes		276	Ateles t
Select All	Select records by com	posin	276	Ateles t
			276	Ateles t
Add Field	47-		279	Ateles g
Turn All Fields	; On	4336	2279	Ateles g
		3678	2279	Ateles g
	Find and Repl Select By Attri Clear Selection Switch Select Select All Add Field	Clear Selection Switch Select Select By Attributes Select All Select records by com auery.	Find and Replace     d_1       Select By Attributes     d_1       Clear Selection     3634       Switch Select     Select By Attributes       Select All     Select records by composing query.       Add Field     query.       Turn All Fields On     4336	Find and Replace     d_1     id_no       Select By Attributes     3634     1807       Clear Selection     3634     1807       Switch Select     Select By Attributes     276       Select All     Select records by composing a query.     277       Turn All Fields On     4336     2279



c. To only include categories as advised by IUCN Presence - 1 (extant); 2 (probably extant);
 6 (presence uncertain) Origin – 1 (native); 2 (reintroduced); 5 (origin uncertain)
 Put the following expression into the Select by Attributes window:-

( "presence" = 1 OR "presence" = 2 OR "presence" = 6) AND ("origin" = 1 OR "origin" = 2 OR "origin" = 5)

HTML Popup Launch an HTML popup by clicking on a feature.	ect by Attributes tera WHERE clause to select records in the table window. ethod : Create a new selection "FID" "OB ECTID" "objectid_1" "id_ne"		~	; ocorer	erencing , lauapain	Search	Maps (
🗄 •   🖶 •   🖳 🌄 🖸	"binomial" •						
col_crenvu	= <> Like	14					
FID Shape * OBJE	> >= And	BI	nce	origin	compiler	year	
O Polygon			1	1	IUCN	2008	IUCN (Intern
1 Polygon	< <= Or		1	1	IUCN	2008	IUCN (Interr
2 Polygon	Not Not		2	1	IUCN	2008	IUCN (Interr
3 Polygon	_% () Not		1	1	IUCN	2008	IUCN (Interr
4 Polygon	Is In Null Get Unique Values Go To:		1	1	IUCN	2008	IUCN (Interr
5 Polygon			1	1	IUCN	2008	IUCN (Intern
	SELECT FROM col_crenvu WHERE:		- Ve	erifying exp	oression		X
7 Polygon	("presence" = 1 OR "presence" = 2 OR "presence" = 6) AND						terr
8 Polygon	("origin" = 1 OR "origin" = 2 OR "origin" = 5)						terr terr terr terr
9 Polygon				The expres	sion was successfully	verified.	terr
10 Polygon					-		terr
11 Polygon	T						
12 Polygon	Clear Verify Help Load Save						terr
•	Code Voliny Loop Lood Save					ОК	
H 4 1 → H	Apply Close		L	_			
col_crenvu		9					

- d. Click Verify to Check the expression, then click OK and Apply
- e. Click Close to close the Select by Attributes window.
- f. The attribute table will show the filtered records highlighted in blue, and the number of records that have been selected. Close the attribute table. Right click on the IUCN spatial dataset (e.g. col\_crenvu.shp) and Click Data>>Export Data.
- g. Ensure that you are exporting the selected features, then save the file with a new name,
  e.g. col\_crenvu\_POselection.shp (as file type shapefile) and click Save. It will ask you if you would like to add the new file to dataframe. Click Yes.

#### 2.1.2. From the previous selection select out only terrestrial species ranges

- a. Right click on the **newly added subset species layer** (e.g. **col\_crenvu\_POselection.shp** in this example) and and click **Open attribute table.**
- b. Click on the top left button and click Select by Attributes.
- c. To only include species which are terrestrial put the following expression into the Select by Attributes window:
- "biome\_terr" = 't'
  d. Click Apply
- e. Click Close to close the Select by Attributes window.
- f. The attribute table will show the filtered records highlighted in blue, and the number of records that have been selected.
- g. Close the attribute table. Right click on the IUCN spatial dataset e.g.
   col\_crenvu\_POselection.shp in this example and Click Data>>Export Data.
- h. Ensure that you are exporting the selected features, then save the file with a new name, e.g. col\_crenvu\_POselection\_T.shp in this example and Click Save. It will ask you if you would like to add the new file to dataframe. Click Yes.

{	Sel	lect by Att	rributes 📒	x
8	E	Enter a WH	ERE clause to select records in the table window.	
	N	Method :	Create a new selection	-
		"biome_m "biome_fw "biome_te "shape_Le	/" #"	^ <del>-</del>
		"shape_A	rea"	-
		- <	<> Like Y And And	
		_% (	() Not Get Unique Values Go To:	-1
	5		ROM nga_iucn_selection_PO_T_clips_mergeall WHERE:	
		"biome_ten	<sup>20</sup> = ¥	*
1		Clear	Venfy Help Load Save.	•
e			Apply Close	

#### 2.2. Instructions for adding the ExploringMultipleBenefits ArcGIS toolbox to ArcMap

The ExploringMultipleBenefits toolbox is designed to make spatial analysis steps quicker and easier to perform. In the standard ArcGIS toolbox there are multiple ways in which users can overlay datasets. Without the ExploringMultipleBenefits toolbox, users would need to find relevant tools, and understand how and when to use them. With Raster analyses in particular, it is important to use and apply appropriate environment settings to the data which are often hidden and forgotten. The ExploringMultipleBenefits toolbox not only standardizes the way that analysis is undertaken in a series of simple steps, but reduces the risk of errors.

The tools are designed to allow users to create their own workflows using combinations of tools in different orders. Each tool clearly outlines what user inputs are required for each of the defined 'parameters'. This information is also stored in the help pages, clearly visible from within the ExploringMultipleBenefits toolbox. There are also a series of modules which are designed to run a specific analysis step by step.

The following steps need to be taken in order to use the ExploringMultipleBenefits toolbox, available at <u>http://bit.ly/GIStools-redd</u>.

a. Unzip the ExploringMultipleBenefits toolbox and save the file to chosen location.

Note: the default area to which ArcGIS saves toolboxes is c:\Documents and Settings\<username>\Application Data\ESRI\ArcToolbox\My Toolboxes.

 Make sure you keep the toolbox in a sub-folder called ExploringMultipleBenefitsTools otherwise the tools may show broken links.

It may be preferable to save the toolbox within a current project folder.

C. Open the ArcMap software and activate the spatial analysis extension by clicking on
 Customize>>Extensions and ensure that the Spatial Analysis extension is ticked.

	ensions you want t	o use.	
- 3D A	nalyst		
	statistical Analyst		
- Mapl	ex		
	vork Analyst		
Publi			
	anaucs ial Analyst		
	king Analyst		
escription:			
Spatial Analys			
Spatial Analys	t 10.0 999-2010 ESRI Inc	:. All Rights Reser	ved
entre Entre in		and the second second	
Spatial Analys Copyright ©19	999-2010 ESRI Inc	and the second second	
Spatial Analys Copyright ©19	999-2010 ESRI Inc	and the second second	

d.

Note: This extension is required to run the ExploringMultipleBenefits tools, therefore if this extension is not available the software vendor will need to be contacted to obtain a licence.

e. Next you need to Add the ExploringMultipleBenefits toolbox to ArcToolbox.



In ArcMap if the ArcToolbox is not already open, **click on the red toolbox button located in the main** horizontal menu bar or from the main menu, click on **Geoprocessing>>ArcToolbox**. The ArcToolbox window will open.

f. Right click on ArcToolbox and click Add Toolbox



**g.** Navigate to the folder in containing the toolbox (location determined in step a.) and click open



#### 2.3. Running the species richness models in the Exploring multiple benefits toolbox

#### a. Expand the module Generating Species Richness from IUCN Red List Data.



## b. The script CheckForEmptyRasters is used the Step 4 model. Right click on the script and click properties.

- c. Click on the Source tab
- **d.** Check that the Script File is pointing to the location of the

Check\_for\_empty\_rasters.py.

e. Click OK

Now you are ready to run the models starting at Step 1.

CheckForE	mptyRas	ters Properti	es				X
General	Source	Parameters	Validation	Help			
Script F	ile:						
D:\IU	N_Redlist	\Check_for_e	mpty_raste	rs.py		2	
Sho	v comman	d window wh	en executing	) script			
🔽 Run	Python se	ript in proces	s				
			ОК		Cancel		Apply

#### 2.3.1. Creating a snapraster

We want to create a snap raster in the projection used by the Colombia data – (i.e. Lambert Azimuthal Equal area, central meridian -73 degrees, Latitude of Origin 4 degrees.)

NOTE: If you already have a raster which you want to use as your 'area of interest', rather than creating a new raster from a shapefile as is done in this step, and provided that it is the right cell size, you may want to skip Step 1. Alternatively if you want the cells of your final species richness raster to align to an existing raster, use **Tool 01b: Create a Snap Raster called 'SNAPGRID (from a raster**) from the **ExploringMultipleBenefits\_v10\_3.tbx** toolbox near the top of the **Core Raster Analysis Toolset**.

- a. Double click on Step 1 Create a Snap Raster called 'SNAPGRID' (from a vector) to open the tool dialogue
- b. The input features is the area of interest file e.g. in this example from
   Colombia la.shp.
- c. Chose a numeric field for the ID. As the snap raster is only being used for setting the extent and snapping environment it does not matter what this field contains.
- d. Chose a cell size for the ' analysis. The units are in the projection of your area of interest file.

Input Features			
Colombia_la		<b>•</b>	Ľ
Expression (optional)			
			sq
Field			
Output cell size (optional)			
1000			Ľ
Extent (optional)			
Same as layer Colombia_la		•	P
/ T—	Тор		
Left	1045220.037323	Right	
-951222,361114		684594,360969	
	Bottom		
	-908516.152184		
Output Coordinate System (optional)			
Same as Layer "Colombia_la"		•	P
Landard drive that a surd area dot			
Lambert_Azimuthal_equal_area_OOL			
Output Raster (to be called snapgrid)			
D:\IUCN_Redlist\snapgrid			P
(			

- e. Set the extent to be the same as your area of interest file.
- f. Set the output Coordinate system to be the same as your area of interest file.
- g. Navigate to an output folder and call the output raster snapgrid.
- h. Click OK to run Step 1.

The resulting **snapgrid** is added automatically to the .mxd file in Arcgis 10.3, but in earlier versions you may have to find snapgrid and add it to the .mxd manually. If this has to be done, do not generate pyramids, if asked if you would like to do so.



#### 2.3.2. Split the species data into individual species files

The rest of the steps need the species dataset to be split into individual species (i.e. a single dataset per species. This will allow us to subsequently generate a 'heat' map showing how many species overlap in a particular area.

# a. First, we need to download and use the following tool <u>http://www.umesc.usgs.gov/management/dss/split\_by\_attribute\_tool.html</u>

🗲 🗇 🜌 http://www.umesc.usgs.gov/r 🔎 👻 Split By Attribute Tool - Des 🗙	☆ 🛱
👍 🔞 QGIS select feature, add t 🕜 Tasks by main 🗸 Toodled 🕨 Suggested Sites 🔻 🗿 Web Slice Ga	llery 🔻 🙆 Explore Layers - UNEP-W
Visit Science for a changing world         Visit Sciences Center	Lawrence U Contact USGS Lake Contact USGS Search USGS
Home Who We Are 🔻 Science Programs 🔻 Maps, Tools, and Database	es 🔻 Products and Publications 👻
Outreach and Education 🔻 Contact Us 🝷 Search	
Decision Support Systems	
Split By Attribute Tool	
The <b>Split By Attribute Tool</b> is a customization of ArcMap 10. The tool takes a single the unique values of a chosen field.	shapefile and splits it into many shapefiles based on
FoxSplitByAttributeAddin 10 1.zip	Split By Attribute
FoxSplitByAttributeAddin 10 2.zip	Feature Layer
FoxSplitByAttributeAddin10 3 1.zip	Example Layer 💌
To install:	Split Field
<ol> <li>Save the file: FoxSplitByAttributeAddin.zip to your local hard drive</li> <li>Extract contents</li> <li>Double click FoxSplitByAttributeAddin.esriAddIn file</li> <li>Open ArcMap 10</li> <li>Click on the Customize menu and the Customize Mode item</li> <li>On the Customize dialog click the Commands tab</li> <li>Soroll down and click on Fox Tools in the Categories list</li> </ol>	Example_Field   Base Name Output Directory C:\Temp\SBA Example Layer Browse
<ol> <li>Beron down and click on rox roos in the citegories inst.</li> <li>Drag the Split By Attribute button to a toolbar on the ArcMap 10 interface</li> </ol>	Only export selected features OK
F	igure 1. The Split By Attribute dialog.
To use:	
1. Click the Split By Attribute button to open the Split By Attribute dialog (Figu	re 1)
2. Choose a Feature Layer to split into component layers	~

b. Select the version that matches your ArcGIS software. In this example we are using ArcGIS 10.3 so we download FoxSplitByAttributeAddin10\_3\_1.zip and save it into a chosen folder. In this example we have placed it into D:\IUCN\_RedList. It puts it into a subfolder called FoxSplitbyAttribute\_10\_3

Computer  Local Disk (D:)  IUCN_Red	list FoxSplitbyAttribute_10_3
Organize  Include in library  Share with	New folder
Working session Sept 2015 2_programs (10.2.0.54)	^ Name
<ul> <li>Zprograms (10.2.0.54)</li> <li>Recycle Bin</li> </ul>	FoxSplitByAttributeAddin.esriAddIn
📕 gisdata	

c. Double click on the split by attribute tool to install it

- Esri ArcGIS Add-In Installation Utility d. Click install Addin Please confirm Add-In file installation e. In ArcMap click on customize >> Active content, such as Macros and Add-In files, can customise mode contain viruses or other security hazards. Do not install this content unless you trust the source of this file. f. Click on the commands tab and type Split By Attribute Name: split in the box to filter. You should see 1.0 Version: Foxtools, Click on it. Tim Fox Author: Splits a feature layer into multiple layers based on the Description: Customize unique field values. Digital Signature/s Toolbars Commands Options This Add-In file is not digitially signed. Show commands containing: split Signed By: Categories: Comman<u>d</u>s: Signed date: Advanced Edit Tools Show Certificate Split By Attribute Analysis Tools Source is trusted Coverage Tools Signature is valid Data Management Tools Editor Install Add-In <u>C</u>ancel Parcel Topology Drag the icon and drop into g. one of your menu bars Description h. Click Close i. Double click on the icon to Keyboard... 🛞 Add From File... Close run the tool
  - j. The feature layer is the one containing your species EOO polygons
  - k. The split field is the species id (id\_no)
  - You can put a prefix e.g. S\_ (otherwise the names will just be the species id number and raster's starting with a number may cause trouble
  - Mavigate to the folder you want to place it in. The tool will automatically create a folder called SBA\_name of your input file
  - n. Click OK to finish. Within the File Geodatabase, the different species have now each got individual layers (see below):

<sup>8</sup> B <sub>A</sub> Split By Attribute
Feature Layer
col_crenvu_POselection
Split Field
id_no 🔻
Optional Output Prefix
S_
Output Directory
UCN_Redlist\SBA col_crenvu_POselection Browse
Only export selected features
ОК

ile Edit View Go Geoprocessing Customize Windows Help	D		
실 🖴 🗐 🖹 🗙 ! # 🏭 🎆 # ! Q ! 💱 🗔 🚳 🗖 [ > ]			
D:\IUCN_Redlist\SBA.col_crenvu_POselection\SBA.gdb	<b>•</b> <del>•</del>		
🚽 🗈 💂 🖕			
italog Tree	Preview Description		
🔚 Folder Connections	Name	Time	
🗉 🚰 C:\		Туре	
🖃 🚝 D:\	⊠ S_11008	File Geodatabase Feature Class	
🗉 🔚 \$RECYCLE.BIN	🖾 S_11175	File Geodatabase Feature Class	
ArcGIS_Georeferencing_tutorial		File Geodatabase Feature Class	
🗉 🧰 carbon	🖾 S_11534	File Geodatabase Feature Class	
E COUNTRY_WORK	🖾 S_11699	File Geodatabase Feature Class	
DATA_COPYONLY	🖾 S 12272	File Geodatabase Feature Class	
🗄 🧰 DMWG	S 12273	File Geodatabase Feature Class	
🗉 🧰 Downloads	S 12815	File Geodatabase Feature Class	
	I S 12820	File Geodatabase Feature Class	
	I S 12914	File Geodatabase Feature Class	
FoxSplitbyAttribute 10 3	⊠ S 13382	File Geodatabase Feature Class	
IUCN_Red_List_Received_May_2015	⊠ S 135446	File Geodatabase Feature Class	
Good files	I 35747	File Geodatabase Feature Class	
GBA col_crenvu_POselection			
BA.gdb	⊠ S_136028	File Geodatabase Feature Class	
Section 2 100 100 100 100 100 100 100 100 100 1	⊠ S_136033	File Geodatabase Feature Class	
B speciesrichness_raster_DRAFT160301.tbx	I S_136124	File Geodatabase Feature Class	
OL_CRENVU.mxd	⊠ S_136232	File Geodatabase Feature Class	
COL_CRENVU.xlsx	🖾 S_136244	File Geodatabase Feature Class	
🖾 col_crenvu.shp	🖾 S_136299	File Geodatabase Feature Class	
COL_CRENVU.csv	🖾 S_136301	File Geodatabase Feature Class	
col_crenvu_POselection.shp	T R 14026	Eile Goodstabase Feature Class	

Check the number of Species layers in SBA.gdb. To do this, open ArcCatalog, **navigate to the SBA** geodatabase e.g. in this example located in D:\IUCN\_Redlist\SBA col\_crenvu\_POselection\ SBA.gdb, click on the first file under Contents (in this instance S\_11008), then scroll down to the bottom file (in this instance S\_8005), hold the up arrow on your keyboard, and click on the last file e.g. S\_8005. The total number of layers is listed at the bottom of the ArcCatalog window. In this instance 403 layers were generated. Compare this to the original list e.g. rl2.dbf. In this example there were originally 418. The 15 missing files will mean that either there was no polygon or that the polygon fell outside of the area of interest.

		s Help	
.   🖴 🖾   🗊 💼 🗙   111 🏭 🎹 11   Q   🕼 🐺		┣━ ┏ : €	
IUCN_Redlist\SBA col_crenvu_POselection\SBA.gdb		<b>•</b> <del>•</del>	
		_	
log Tree	Ψ×	Contents Preview Description	
🗄 🚰 C:\	*	Name	Туре
🖃 🚝 D:\			21
🗄 🧰 \$RECYCLE.BIN		I S_56982	File Geodatabase Feature Class
ArcGIS_Georeferencing_tutorial		I S_56984	File Geodatabase Feature Class
🗄 🧰 carbon		🔟 S_56985	File Geodatabase Feature Class
		I S_57011	File Geodatabase Feature Class
⊞ DATA_COPYONLY ⊞	=	⊠ S_57015	File Geodatabase Feature Class
DMWG     Downloads		🖾 S_57032	File Geodatabase Feature Class
		🖾 S_57036	File Geodatabase Feature Class
IPBES_request		🖾 S_57046	File Geodatabase Feature Class
IUCN Redlist		I S_57061	File Geodatabase Feature Class
FoxSplitbyAttribute 10 3		I S_57068	File Geodatabase Feature Class
IUCN_Red_List_Received_May_2015		🖾 S 57081	File Geodatabase Feature Class
🗄 🛅 old_files		I S 57198	File Geodatabase Feature Class
🖃 🚞 SBA col_crenvu_POselection		I S 57203	File Geodatabase Feature Class
🗉 🧊 SBA.gdb		I S 59142	File Geodatabase Feature Class
🗉 🧊 IUCN_boolean1_nd.gdb		I S 59178	File Geodatabase Feature Class
🗄 👰 ExploringMultipleBenefits_v10_3_160613.tl	x	I S 59192	File Geodatabase Feature Class
Speciesrichness_raster_DRAFT160301.tbx		I S 59206	File Geodatabase Feature Class
OCL_CRENVU.mxd		⊠ S_59200 ⊠ S 61173094	File Geodatabase Feature Class
		S 61817	File Geodatabase Feature Class
Image: Col_crenvu.shp COL_CRENVU.csv		S 62144610	
COL_CRENVU.csv COL_CRENVU.POselection.shp			File Geodatabase Feature Class
COL RL.mxd		₩ S_6494	File Geodatabase Feature Class
Colombia_la.shp		I S_6608	File Geodatabase Feature Class
		🔟 S_6664	File Geodatabase Feature Class
snapgrid		I S_8005	File Geodatabase Feature Class

#### 2.3.3. Create Boolean species rasters

#### a. Double click on Step2 CreateBooleanSpeciesRasterGDB

Step 2 CreateBooleanSpeciesRastersGDB	
OutLoc	OutLoc
D: \IUCN_Redlist	
OutFileGDB	No description available
IUCN_boolean1_nd	
*	-
OK Cancel Environments << Hide Help	Tool Help

- **b.** Specify and output location in the **OutLoc** tab.
- c. Leave the filename as the default IUCN\_boolean1\_nd.
- d. Click OK to run.

This step only takes a few seconds to run as it simply creates an empty file Geodatabase ready for the next step.

- e. Now double click on Step 3 CreateBooleanSpeciesRasters. This model converts polygons to rasters for all the species in your SBA.gdb
- f. Select the SBA geodatabase 🔭
- g. Set the Output Coordinate system, cell size, Extent,
  Mask and Snap Raster to be Same as Layer snapgrid.
- **h.** Then click Close when finished.
- Check the number of rasters produced and compare with the original number of layers.
- j. Outloc is the location you specified in step b)
- k. The OutfileGDB is IUCN\_boolean1\_nd
- I. The value field leave as unique
- m. Click OK to run the step

D:\IUCN_Redlist\SBA col_crenvu_	POselection\SBA.gdb		6
Output Coordinate System (option	al)		
Same as Layer "snapgrid"		▼	1
Lambert_Azimuthal_equal_area_0	COL		
Cellsize (optional)			
D:\IUCN_Redlist\snapgrid			1
Extent (optional)			
Same as layer snapgrid		•	1 🖻
	Тор		
	1045483.847816		
Left		Right	
-951222.361114		684777.638886	
	Bottom -908516, 152184		
	-908516,152184		
OutLoc			_
D:\IUCN_Redlist			1
OutFileGDB			
IUCN_boolean1_nd			
Value field			
unique			•
Mask (optional)			
snapgrid		•	1
Snap Raster (optional)			
snapgrid		•	P A
, , , , , , , , , , , , , , , , , , , ,			

**n.** Again, check the number of rasters using ArcCatalog in the same way. There should be the same number of rasters (in this example 403).

This process took about half an hour to run in this example

#### 2.3.4. Check to see if any of the Boolean Rasters are empty

The next step is to check to see if any of the outputs from the previous step are blank as this would cause trouble in step 2.3.5. Blank outputs mean that the species polygon did not cross into the area of interest. This step deletes any of these empty rasters, and lists these in a file called **EmptyRastersDeleted.txt**.

- a. Double click on Step 4 Check to see if any of the Boolean Rasters are empty and navigate to the File geodatabase containing the rasters created in step 3 (IUCN\_boolean1\_nd) and click OK.
- b. Navigate to the IUCN\_boolean1\_nd.gdb
- Cutside of ArcMap, create a text file called EmptyRastersDeleted
   .txt and in ArcMap point step 4 to this file

The model will delete any empty rasters and will list them in a text file

â
2
2
-
elp

EmptyRastersDeleted.txt - Notepad	X	3
File Edit Format View Help		
D:\IUCN_Redlist\IUCN_boolean1_nd.gdb\S_54536		*
		Ŧ
×	Þ	Щ

This process takes around twice the length of time as the conversion to rasters. For this example, it took just under an hour.

**d.** Click **Close** and then again check the number of rasters in the output geodatabase (**IUCN\_boolean1\_nd.gdb**) in ArcCatalog.

In this example there are **402** rather than 403 rasters, indicating that one of the rasters were empty. This is confirmed by the one reference in the **EmptyRastersDeleted** text file which indicated which species was deleted.



#### 2.3.5. Convert no data to 0 in Boolean Rasters

This next step will create a new file GDB contains the same rasters as the previous step but they will all have had their no Data values converted to 0 (zero). This is necessary to enable the raster to be successfully summed in the final step.

- a. Double click on Step5 CreateGDBforConvertNoDataTo0
- Specify and output location in the OutLoc tab.
- c. Leave the filename as the default IUCN\_boolean1\_0.
- d. Click OK to run.

Per Step 5 CreateGDBforConvertNoDataTo0		
Location		*
D:\IUCN_Redlist		
File GDB Name IUCN_boolean1_0		
		-
OK Cancel Environments	Hide Help	

This step only takes a few seconds to run as it simply creates an empty file Geodatabase ready for the next step.

r

		🔤 St	Step 6 convertNoDataTo0
0.	Now double click on Step 6		IUCN boolean1_nd.gdb
	ConvertNoDataTo0. This model		D:\IUCN_Redist\IUCN_boolean1_nd.gdb
	converts no data values to 0 in all		Reclass field
	the species rasters in the		Value   Redassification
	IUCN_boolean1_nd.gdb		Old values New values
p.	Select the IUCN_boolean1_nd	_	1 1 Classify
	geodatabase		Unique
q.	Set the <b>reclass field</b> to <b>Value</b>		Add Entry
r.	Set the reclassification, 1 to remain	ſ	Delete Entries
	as 1 and <b>no data to become 0</b> .	-	
s.	The <b>OutfileGDB</b> is		Load Save Reverse New Values Precision
	IUCN_boolean1_0		OutFileGDB · IUCN_boolean1_0
t.	Outloc is the location you specified		OutLoc
	in step b)		D:\IUCN_Redlist
u.	Set the cell size, Extent, Mask and		Same as layer snapgrid
	Snap Raster to be Same as Layer		1000
	snapgrid.		Mask (optional)
v.	Then click Close when finished.	· ·	snapgrid 🗾 🖻
w.	Check the number of rasters		Same as layer snapgrid 🔹
	produced and compare with the		Top 1045483.847816
	original number of layers.	-	Left Right -951222.361114 684777.638886
x.	Click <b>OK</b> to <b>run the step</b>		Bottom
y.	Again, check the number of rasters		-908516.152184
	using ArcCatalog in the same way.		Snap Raster (optional) snapgrid
	There should be the same number		
	of rasters (in this example 402).		
			OK Cancel Environments << Hide Help

#### 2.3.6. Sum the raster to create a species richness dataset

The last step is to run the weighted sum. All the datasets will be given the same weight so the tool will just sum each raster together.

- **a.** Double click on the Weighted Sum tool
- **b.** Click the folder button to navigate to the **IUCN\_boolean1\_0** geodatabase to pick up all the raster files.

Weighted Sum				Weighted Sum
Raster	Field	Weight	+ × +	Overlays several rasters, multiplying each by their given weight and summing them together.
Output raster	III OK Cancel	Environments	< Hide Help	Tool Help

- c. Hold down shift and select all the files.
- d. Click Add

ook in: 📋 IUCN_boolean	1_0.gdb 🔹 🔁 👍 🎲 🗮 🕇 🔛 🖆 🗍	
Name	Туре	-
IIII S_59206	File Geodatabase Raster Dataset	
IIII S_61173094	File Geodatabase Raster Dataset	
IIII S_61817	File Geodatabase Raster Dataset	
IIII S_62144610	File Geodatabase Raster Dataset	
IIII S_6494	File Geodatabase Raster Dataset	
IIII S_6608	File Geodatabase Raster Dataset	
IIII S_6664	File Geodatabase Raster Dataset	
<mark></mark> S_8005	File Geodatabase Raster Dataset	-
Name: S_11008; S	_11175; S_11510; S_11534; S_11699; S_1227. Add	

				- 🖻	The output suitability raster.	
Raster	Field	Weight		•	The output suitability faster.	
D:\IUCN_Redlist\I	Value	1			It will be of floating-point type.	
D:\IUCN_Redlist\I		1		×		
D:\IUCN_Redlist\I	Value	1				
D:\IUCN_Redlist\I	Value	1				
D:\IUCN_Redlist\I	Value	1		I I		
D:\IUCN_Redlist\I	Value	1				
D:\IUCN_Redlist\I		1	•	-		
•	III					
Output-reader						
D:\IUCN_Redlist\col_CRE	VVU_sum.tif			<b>6</b>		
				_		

- e. Navigate to an **output folder** and give the species richness output raster a name.
- f. Click **OK** to run this final step

The final dataset can then be symbolized and placed in a map layout as in the example below. In this example the values refer to the total number of Critically Endangered, Endangered and Vulnerable species whose ranges include each grid cell. Remember that this does not guarantee species presence.



#### **Example Species Richness Map**