## 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 VECTOR METHOD IN A COMBINATION OF QGIS 1.8 AND 2.8



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 the United Nations Environment Programme (UNEP).

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

#### Prepared by Corinna Ravilious, Lucy Goodman, Blaise Bodin, Lisen Runsten and Matea Osti

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These training materials have been produced from materials generated for working sessions held in Tanzania with the National Forestry Resources Monitoring and Assessment of Tanzania, FAO Tanzania and Sokoine University, and the Democratic Republic of the Congo with OSFAC, to aid the production of multiple benefits maps to inform REDD+ planning and safeguards policies using open source GIS software.





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## **1. Introduction**

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. 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.

Open Source GIS software can be used to undertake spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+. Open-source software is released under a license that allow software to be freely used, modified, and shared (<u>http://opensource.org/licenses</u>). Open Source GIS software can be used to undertake spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+. Open-source software is released under a license that allow software to be freely used, modified, and shared (<u>http://opensource.org/licenses</u>). Therefore, using open source software has great potential in building sustainable capacity and critical mass of experts with limited financial resources.

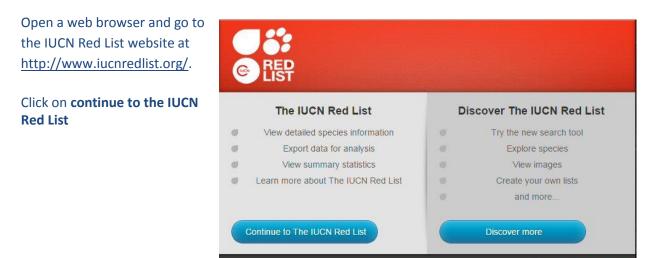
This tutorial demonstrates how a species richness grid could be created using species range data from the IUCN Red List (IUCN, 2013). It provides full instructions of how to select and analyze and export information from the non-spatial species data on the IUCN Red List website and how to further analyze the information along- side the IUCN spatial data using QGIS, an open-source desktop GIS software. Please note that the last part of the tutorial can currently only run in QGIS version 1.8 as it is reliant on the QMarxan plugin that is not yet available in more recent versions.

## 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

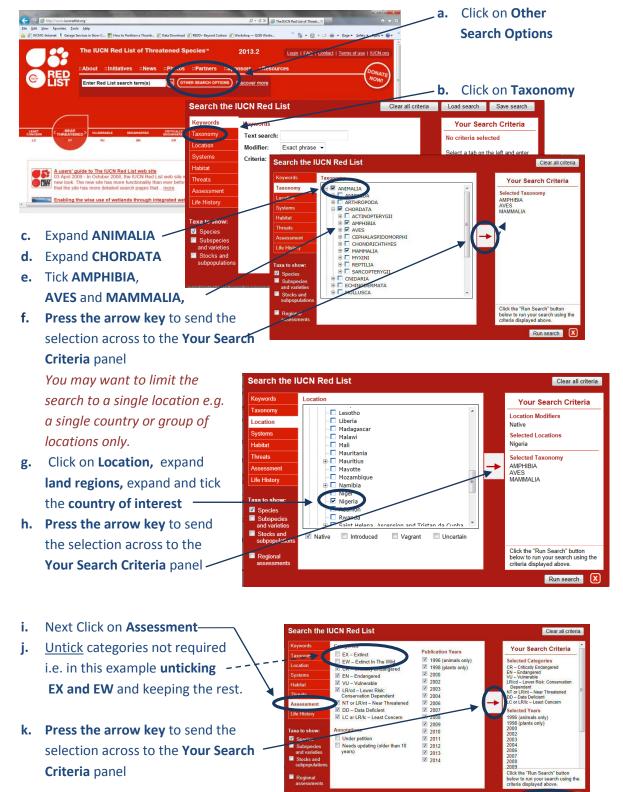
The IUCN Red List of Threatened Species website allows users to search for and extract tabular information (in comma separated values (CSV) file format) on the status of threatened species. The website provides a user friendly interface and gives the user flexibility to customize searches based on a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

## 2.1.1. Searching for non-spatial data



Remember my selection

This search below is an EXAMPLE search for mammals, birds and amphibians with threat status of Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Lower Risk: Conservation Dependent (LR), Near Threatened (NT), Data Deficient (DD) or Least Concern (LC).



I. Click Run search

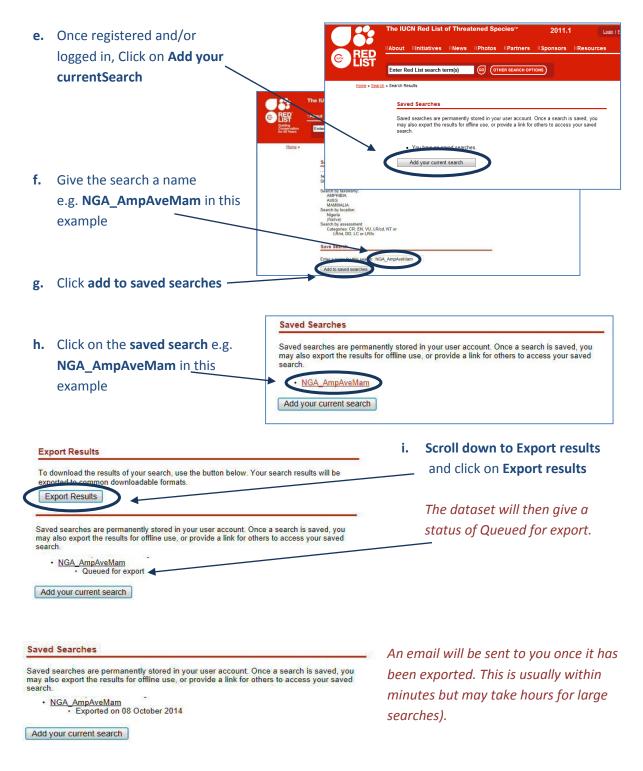
This search will result in a list of species within the AMPHIBIA, AVES and MAMMALIA taxonomic groups that have critically endangered, Endangered, Vulnerable, Lower Risk: Conservation Dependent, Near

Threatened, Data Deficient or Least Concern Red List status. The search will produce a list of species with 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, the expand and tick the relevant habitat type and send that across to the search criteria panel.

#### The IUCN Red List of Threatened Species 2014.2 Login | FAQ | Contact | Terms of use | IUCN.org Click a. t ::Initiatives ::News ::Photos ::Partners ) REP Save/Export Search Enter Red List search term(s) OTHER SEARCH OPTIONS Discover more Home > Search > Search Results b. If already registered, Displaying species assessments 1 - 50 of 1241 in total Current search: 7 2 3 4 5 6 7 8 9 ... 24 25 Next --fill in your email address Acanthi Status I 59% w taxa: Species 1 ver 3.1 and password and click 🗄 🔹 🏀 Logir × Google he IUCN Red List of Threaten ad Sr 2011.1 Login login Thre ::Sp Enter Red List search term(s) 60 OTHER SEARCH OPTIONS c. If you have not yet Home » Login registered, you need Login to create an Login account You must log in to access advanced IUCN Red List functionality. Please enter your e-mail address and p (see box below) E-mail addres Password: Login An account is reate Account or Request New Password needed in order to If you do not have an IUCN Red List user account, or if y please enter your e-mail address below. A password will we forgotten your password, ent to the address you provide E-mail address: save and export stedsuc the search results. energy d. New users will be asked to fill out the details in the box below The first time new users export a search, they are required to fill out some information User Information about themselves and the intended use of We agree to respect your privacy. Please see our privacy policy the data First name Last name Mailing address (optional) Phone number (optional) Click on Supply your Country of (Please select a country:) **information** and fill in the requested details (no permanent residence) Afghanistan Albania Algeria Ξ (Hint: On many browsers, press the first letter of your country name to jump in the list.) Click on Submit Affiliation (Please select a sector:) -Please indicate how you intend to use the exported IUCN Red List data:

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



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 IUC	N Red List	of Three	atened Sp	oecies™	2014.2	My Downloads	) AQ   Contact   Terms of use   IUCN or	rg
6		::About	::Initiatives	::News		::Partners	:: Sponsors	::Resources		TE
	Guiding Conservation for 50 Years	Enter	Red List search	1 term(s)	6	THER SEARCH O	PTIONS Discon	<u>ver more</u>		

aved Searches					
aved searches are permanently stored in your user account. Once a search is saved ay also export the results for offline use, or provide a link for others to access your s arch		k.	Click on the <b>exported search</b> e.g. <b>NGA_AmpAveMam</b> in this		
NGA AmpAveMam     Exported error October 2014  Add your current search			example		
Loadi Search Loading this search will replace your current search. Please save your search if you may wish to return to it later.	I.	Scroll	down to the Export results		
Load this search      Permalink      To allow others to view your search results, you may copy and distribute the following link:     http://www.iucnredlist.org/apps/redlist/search2mt/4eb90157-b44da2f0	m.		on <b>Comma-Separated Values (CSV)</b> he zip file will download		
Export Results Your search results have been exported. Please use the links below to download the export in your preferred format(s).  Comma-Separated Values (CSV) Extension: the input for the links below to the links below to download the export in	n.	gener file to	download has placed the file in a ral download folder move the zip a more suitable location e.g. in a rt folder		
Please note that the Red List data may change over time. The exported data is current as of <b>08 November 2011</b> . To obtain the latest data, use the button below; your exported data will be replaced with the most current data.           Refresh Exported Data           Delete Search	0.	Renan	<b>ne</b> the zip file to somthing sensible <b>GA_AmpAveMam.zip</b> in this		
This search is saved to your saved searches as "mam_cr_en". Delete search	р.	<b>Right</b> file	click on zip folder, extract the csv		

#### q. Rename 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. It is important to 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 <a href="http://www.iucnredlist.org/">http://www.iucnredlist.org/</a>
- b. From the Resources tab, click on Spatial Data Download

05:	The IUCN Red List of Threatened Species <sup>14</sup> 2014.2	My Downloads   FAQ   Conta
RED	#About #Initiatives #News #Photos #Partners #Sponsors	Resources
Guiding Conservation for 50 Years	Enter Red List search term(s) (OTHER SEARCH OPTIONS) Discove	Classification Schemes
Home » Re	sources » Spatial Data Download	and the second se
	Spatial Data Download	Information Sources and Quality
Resources	Part Link Constint Parts	
Key Documents	Red List Spatial Data	References
Categories and Crite	ria The IUCN Red List of Threatened Species contains assessments for just ove	Acknowledgements
Classification Schem	of which about two-thirds have spatial data. This spatial data provided below	SIS News and Updates
Data Organization	Conservation for 50 Years       Enter Red List search term(s)       Contract of the search options       Discove       Cytegories and Criteria         Home » Resources » Spatial Data Download       Spatial Data Download       Spatial Data Download       Spatial Data Download         Sources       Spatial Data Download       Spatial Data Download       Spatial Data Download       Spatial Data Download         Sources       Red List Spatial Data       Red List Training       Red List Training         Regories and Criteria       The IUCN Red List of Threatened Species contains assessments for just over of which about two-thirds have spatial data. This spatial data provided below as those listed as Data Deficient are not mapped and subspecies are mapped within the parental species. The data is available as ESRI shapefiles format and contains the known range of each species. The data is available as ESRI shapefiles format and contains the known range of each species. Ranges are depicted as polygons. DBF files accompanying contain taxonomic information, distribution status, sources and other details about the maps	
Classification Schemes Data Organization Spatial Data Download		
Information Sources Quality	and taxonomic information, distribution status, sources and other details about the	

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

	Spatial Data Dow	nload							
Resources	Red List Spatial	Data							
Key Documents	The IUCN Red List of The	eatened Species contains assessn	pante for just over 73 000 energies						
Categories and Criteria Classification Schemes	of which about two-thirds	have spatial data. This spatial data	provided below is for						
Data Organization		ed taxonomic groups. It is important eficient are not mapped and subsp							
Spatial Data Download	parental species. The dat	a is available as ESRI shapefiles fo	rmat and contains the known						
Information Sources and Quality		ange of each species. Ranges are depicted as polygons. DBF files accompanying contain axonomic information, distribution status, sources and other details about the maps see metadata document).							
Assessment Process	Please note that the files	are large and download times coul	be quite lengthy. The Taxonomy						
Red List Training	Table are full taxonomy a	nd Red List status tables providing	higher taxonomy and species						
References		or each group. Please be aware the ta Deficient species not consistently							
Acknowledgements	beginning included within	parental species polygons.							
SIS News and Updates	For ease of distribution ar	nd downloading, the data is divided	by taxonomic groups.						
	conservation planning an Use). For more information <u>Process</u> . Please note that data in analyses or gener For all enquiries about sp More information about <u>S</u>	valiable to the public for non-comm d other decision making processes in about the assessment process, all off off off off off off off off off all GIS support. atial data, please contact the <u>IUCN</u> patial data resources here. page will be available shortly.	(see <u>Terms and Conditions of</u> see <u>Red List Assessment</u> cchnical support for use of the						
	Main Dataset	Specific Group(s)	Descriptions and species lists						
	Mammals 🛃	Marine Mammals 🛃	Includes mammal families for seals, sea lions and walrus, whales, dolphins and porpoises, manatees and dugongs. Excludes mammal families for seals, sea lions and walrus, whales, dolphins and porpoises, manatees and dugongs. Species list from website						
		Taxonomy Table	Species from the order <u>Anura</u> as a shapefile.						
	Amphibians Tailed Amphibians Species from the order <u>Caudata</u> as a shapefile. Species from the order <u>Gaudata</u> as a shapefile.								
		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> .						

- 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 the files are very large and will take some time to download.

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

2.2. Vector Spatial Data Selection and Preparation

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

Open the 'exported search' results csv file (that was downloaded in section 2.3 step m) e.g.
 NGA\_AmpAveMam.CSV in this example. Open the file Excel (or if using completely open source software in Gnumeric or Libre Office Calc) (The Screengrab examples below use Excel.

NGA_AmpAveMam.csv	08/10/2014 12:46 Microsof	t Office E	225 KB
NGA_AmpAveMam.csv.zip	Open       Print       Edit       7-Zip       2       Convert to Adobe PDF       2       Convert to Adobe PDF and EMail       ✓       Scan for viruses	⊧d (zipp	55 KB
X	K Move to Quarantine		
	Open with	Microso	oft Office Exce

<b>C</b>	) 🖬 🕯	<b>9 -</b> (2 -										NGA_	AmpAveMa	m.csv - N	Microsoft Excel					-			U	- 0 <b>-</b> X
9	Hor	ne Ins	ert Pa	ge Layou	t F	Formulas	Data	Rev	iew Vie	w Add	-Ins Ac	robat												0 - 🗉
Ê			Calib	ori	- 11	· · A	Ă ĂĂ (	= =	- *	📑 Wrap	Text	General		•	<b>1</b>	Normal	B	ad		3- 3		Σ AutoSun	* AT	A
Past	to	ormat Pain	ter B	ΙU	·)[[[]]	• 🔕 •	<u>A</u> •			🔤 Merge	e & Center 🕤	<b>₩</b> ~ %	, , .0	Cor For	nditional Format matting = as Table -	Good	N	leutral	Ŧ	Insert Dele	te Format	2 Clear *	Sort & Filter *	
	Clipbo	ard	6		Font		5		Align	ment		i Nu	mber	6		Style	5			Cell	ls		Editing	
	A1		+ ()	$f_{s}$	Spe	ecies_ID																		
	А		в	С	D	E	F	G	Н	1	J	К	L	М	N	0	Р	Q	R	S	Т	U	V	W
1 S	pecies	ID King	dom Ph	vlum C	lass	Order	Family	Genus	Species	Authority	Inf rank	Inf name	Inf auth	Stk sub	pop Synonyms	Com eng	com fre	com spa	rl status	rl criteria	rl version	vear ass	poptrend	Petitioned
2										(Buchholz			-	_		_ 0	_		LC	-	3.1		unknown	
3	22695	490 ANI	MALIA CH	ORDA A	VES	ACCIPIT	ACCIPIT	Accipit	ebadius	(Gmelin, 1	1788)					Shikra	Epervier	shikra	LC		3.1	2012	stable	N
4	2269	486 ANII	MALIA CH	ORDA A	VES	ACCIPIT	ACCIPIT	Accipit	e castanili	Bonaparte	, 1853					Chestnut-	Autour à	flancs rou:	LC		3.1	2012	decreasir	N
5	2269	576 ANII	MALIA C	ORDA A	VES	ACCIPIT	ACCIPIT	Accipit	erythrop	(Hartlaub,	1855)					Red-legge	Epervier	de Hartlau	LC		3.1	2012	decreasir	N
6	22695	673 ANI	VALIA CH	ORDA A	VES	ACCIPIT	ACCIPIT	Accipit	emelanol	Smith, 183	30					Black Spar	Autour n	oir	LC		3.1	2012	decreasir	N
7	22695	619 ANI	VALIA CH	ORDA A	VES	ACCIPIT	ACCIPIT	Accipit	eovampe	Gurney, 1	875					Ovambo S	Epervier	de l'Ovam	LC		3.1	2012	increasin	g N
8	2272	705 ANII	VALIA CH	ORDA A	VÊS	ACCIPIT	ACCIPIT	Accipit	toussen	(Verreaux	& Verrea	ux, 1855)				Red-chest	ed Gosha	wk	LC		3.1	2014	decreasir	N
9		219 ANI	MALIA CH	ORDA N	1AMN	CARNIV	FELIDAE	Acinor	ŋjubatus	(Schreber	, 1775)					Cheetah,	Guépard	Chita, Gu	VU	A2acd; C1	3.1	. 2008	decreasir	N
.0	44	938 ANI	VALIA CH	ORDA N	1AMN	RODEN'	MURIDA	Acomy	sjohannis	Thomas, 1	912					Johan's Sp	iny Mous	e, Johan's !	LC		3.1	2008	stable	N
1										(Temmino		gel, 1847)				Great Ree	Roussero	lle turdoïd	LC		3.1	2012	decreasir	N
2										(Hartlaub,						Lesser Sw	Rousser	lle des ma	LC		3.1	2012	stable	N
L3	22714	1846 ANII	VALIA CH	ORDA A	VES	PASSER	SYLVIID	Acroce	¢ rufescer	(Sharpe &	Bouvier,	1876)				Greater Sv	/ Rousserc	lle des car	LC		3.1	2012	stable	N
4										(Linnaeus						Sedge Wa					3.1		stable	N
15										(Hermann						Eurasian F					3.1		stable	N
.6										Linnaeus,					Tringa hyp	Common					3.1		decreasin	
.7										(Gmelin, 1						African Ja		poitrine do			3.1		stable	N
18										(Thomas,						Tinfields I			DD		3.1		unknown	
19										(Peters, 1						s Brown Ba					3.1		increasin	-
20										Schiøtz, N					Afrixalus	c Nigeria Ba	inana Frog		NT		3.1		stable	N
21	50	5074 ANII	VALIA CH	ORDA A	MPHI	ANURA	HYPERC	Afrixal	L paradors	Perret, 19	60								LC		3.1	. 2013	unknown	N

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

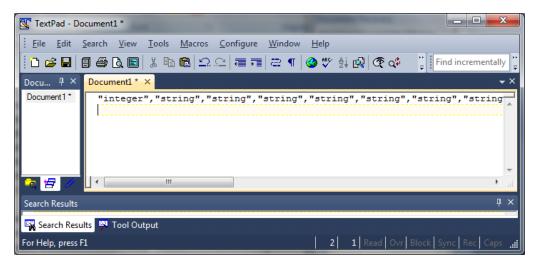
OLD Field Name	=	New Field Name
Species ID	=	Species_ID
Kingdom	=	<b>`</b> Kingdom
Phylum	=	Phylum
Class	=	Class
Order	=	Order
Family	=	Family
Genus	=	Genus
Species	=	Species
Binomial	=	Binomial
Authority	=	Authority
Infraspecific rank	=	Inf_rank
Infraspecific name	=	Inf_name
Infraspecific authority	=	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 (keeping the file format as csv). If it asks if you want to keep the file in this format click yes

Keep the CSV file open as it will be used in section 2.6 where we will use the 'species\_id' column to prepare an SQL query to be used in QGIS.

d. Open a text editor and create a new empty csv file and add the following text to correspond to the data types of each of the columns in the .csv file. e.g. the Species\_ID column should contain integer values

"integer", "string", "stri



These are the data types for each of the fields in the species csv file.

e. Save the file with the same name and in the same folder as the species csv file but with the a .csvt ending e.g. NGA\_AmpAveMam.csvt in this example

This will ensure that when the file is opened later in QGIS that the numeric (Integer) fields are read with the correct data type, otherwise QGIS will default to making all the fields text (string).

The next steps will prepare an SQL query which will be used QGIS to select out the polygons from the large spatial dataset which are in the species list. This method is being used rather than using a 'join' to join the species list to the spatial data because the join function often fails or causes errors on this very large spatial dataset.

f. Go back to the 'species list csv file. e.g. NGA\_AmpAveMam.CSV Then copy and paste the Species\_ID column into column B a new excel worksheet

	А	В	С	D	E	F	G	Н	I	J
1		Species_ID								
2		56055								
3		22695490								
-										

- g. In row 2 of column A type "id\_no" = a (make sure you put a space after the equals sign as this is important for the SQL syntax we are creating
- **h.** In row2 of column C type OR(this time make sure you put a space before the OR as this is important for the SQL syntax we are creating.)
- i. In row 2 of column D type =A2&B2&C2
- j. Next fill Columns A, B, C and D by double clicking on the bottom right hand corner of each cell in row 2
- k. Delete the entire first row so that the file now looks similar to the illustration below

	D2	<del>•</del> (		=A2&B2&C2				
	А	В	С		D	E		
1		Species_ID						
2	"id_no" =	56055	OR	"ic	no" = 56055 OR			
3		22695490						
4		22695486						
5		22695576						
6		22695673						
7		22695619						

	D1	- (		<i>f</i> <sub>x</sub> =A1&B1&C1	
	А	В	С	D	E
1	"id_no" =	56055	OR	"id_no" = 56055 OR	
2	"id_no" =	22695490	OR	"id_no" = 22695490 OR	
3	"id_no" =	22695486	OR	"id_no" = 22695486 OR	
4	"id_no" =	22695576	OR	"id_no" = 22695576 OR	
5	"id_no" =	22695673	OR	"id_no" = 22695673 OR	
6	"id_no" =	22695619	OR	"id_no" = 22695619 OR	
7	"id_no" =	22727705	OR	"id_no" = 22727705 OR	
8	"id_no" =	219	OR	"id_no" = 219 OR	

 Save the worksheet for later to a new file e.g. in this example called formatted\_for\_SQL\_query.xlsx and close

## 2.2.2. Use SQL query to select species of interest from spatial dataset

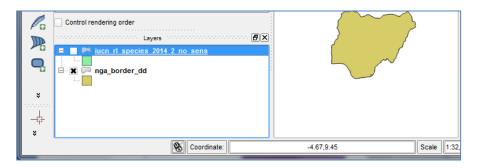
The next section prepares the spatial data ready for analysis. The IUCN spatial dataset is a complex dataset as it contains many overlapping polygons for each species for the entire world. Even subsetting the dataset for your area of interest can be problematic so these set of instructions are important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

- a. Open QGIS
- Add in the IUCN Species spatial dataset(s) (the data are in geographic coordinate system (i.e. EPSG:4326)

🔏 Add vect	tor layer
-Source ty	pe
🔘 File	Directory     O Database     Protocol
Encoding	g System 💌
-Source -	
Туре	ESRI FileGDB
Dataset	C:\NGA_SpeciesRichness\iucn_rl_species_2014_2.gdb Browse
	Open Cancel Help

c. Untick the dataset in the table of contents to stop it drawing

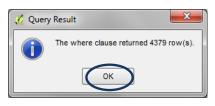
- **d.** Add in a polygon dataset of the area of interest (e.g. country boundary) e.g. in this example **nga\_border\_dd.shp.** Make sure the dataset is in geographic coordinate system (i.e. EPSG:4326) to match the coordinate system of the IUCN spatial data
- e. Click on the IUCN spatial dataset in the table of contents to make it the active layer e.g. in this example iucn\_rl\_species\_2014\_2\_no\_sens



f. Right click on the IUCN spatial dataset and Click Filter

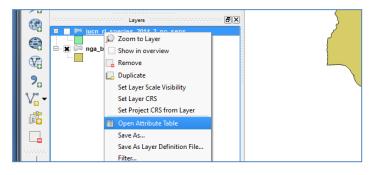
elds	on_n_opeoide	_2014_2_no_se	ins			
				Values		
id_no						
binomial						
presence						
subpop						
data_sens						
sens_comm				2		
legend						
seasonal						
owner						
ecosystem					Sample	All
areakm2					Sample	All
taxonid			<b></b>		Infiltered layer	
subpop id						
-	<	>	LIKE	%	IN NOT IN	
<=	>=	!=	ILIKE	AND	OR NOT	
rovider specific filte	r expression					
"id_no" = 2272001						
"id_no" = 58167 O						
"id_no" = 23144 Of						
"id_no" = 23144 OF "id_no" = 2269264						
"id_no" = 23144 Of "id_no" = 2269264 "id_no" = 2269266	3 OR					
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"id_no" = 23144 OF "id_no" = 2269264 "id_no" = 2269266 "id_no" = 23211 OF "id_no" = 2270842	3 OR R <del>V OR</del>					
"id_no" = 23144 Of "id_no" = 2269264 "id_no" = 2269266 "id_no" = 23211 OF	3 OR R <del>V OR</del>					

- **g.** A Query window appears. **Copy and paste** into the Query window **the SQL query** that you created earlier. This will select out only those species present in the exported species list
- Remove the OR from the last row and click Test to check you got the syntax correct. This may take 5 10 minutes or longer depending on how many records are being selected. If correct it should return the number of rows selected



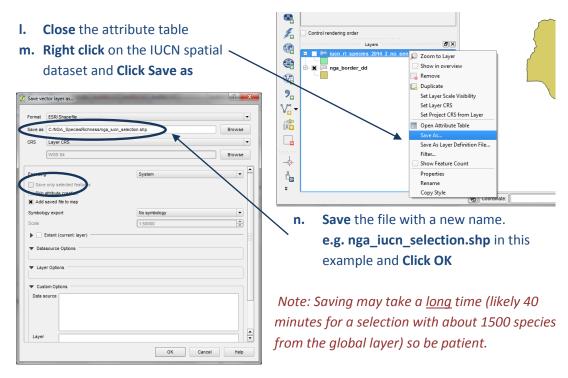
Note: This number does not equate to the number of species but to the number of polygons so you cannot use this to check that the number of species it has selected is correct.

- i. Click OK to close the Query Result window
- **j. Click OK** to apply the filter to the IUCN spatial dataset and close the Query Builder window.
- k. To see that the dataset now only shows the filtered records right click on the IUCN spatial dataset and click on
   Open Attribute table



🌠 At	tribute table - iucn	_rl_species_2014_2	no_sers :: Features	total: 4379, iltere	d: 4379, selected: 0	100
	]		🏶 🗭 📳			
	id_no 🗸	binomial	presence	origin	compiler	year
0	219	Acinonyx jubatus	1	1	IUCN	2
1	219	Acinonyx jubatus	1	1	IUCN	2
2	219	Acinonyx jubatus	1	1	IUCN	2
3	219	Acinonyx jubatus	1	1	IUCN	2
4	219	Acinonyx jubatus	1	1	IUCN	2
5	219	Acinonyx jubatus	1	1	IUCN	2

Note the attribute table shows only the records filtered by the SQL query.



v

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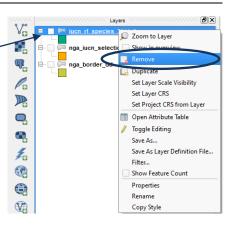
Po

**Q** 

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o. Right click and Remove the IUCN spatial dataset in the table of contents e.g. in this example remove iucn\_rl\_species\_2014\_2\_no\_sens



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💭 Zoom to Laye

C Duplicate

Show in overvie Remove

Set Layer Scale Visibility Set Layer CRS

Set Project CRS from Layer

Open Attribute Table

ggle Edition

how Feature Co

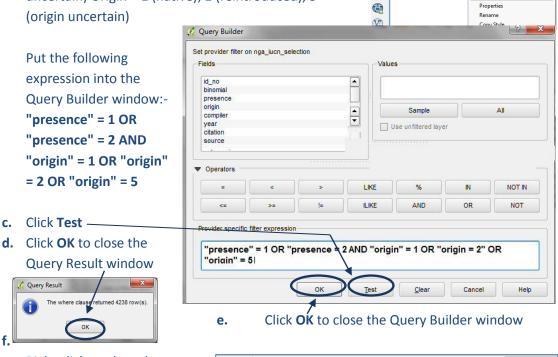
Save As.

Propertie

nga\_border\_dd

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

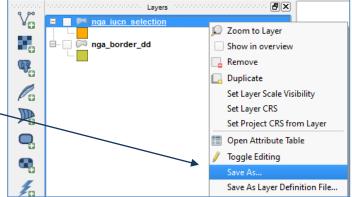
- a. Right click on the newly added subset species layer e.g. nga\_iucn\_selection.shp in this example and and Click Filter ~
- To only include categories as advised by IUCN b. Presence - 1 (extant); 2 (probably extant); 6 (presence uncertain) Origin - 1 (native); 2 (reintroduced); 5



g. Right click on the subset IUCN spatial dataset e.g nga iucn selection.shp in this example and Click Save as ~ h. Save the file with a new

f.

name. e.g. nga\_iucn\_selection\_PO.shp in this example

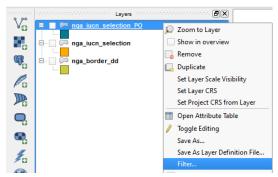


	ctor layer as		
Format	ESRI Shapefile		-
Save as	C:/NGA_SpeciesRichness/nga	_iucn_selection_PO.shp	Browse
CRS	Layer CRS		
	WGS 84		Browse
Encoding	9	System	•
Save	e only selected features		
	attribute creation		
X Add	saved file to map		
Symbolo	gy export	No symbology	-
Scale		1:50000	▲ ▼
	Extent (current: layer)		(
			Cancel Help

i. Click OK -----

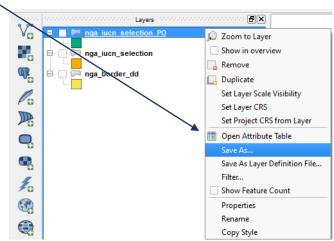
### 2.2.4. From the previous selection select out terrestrial species ranges

- a. Right click on the newly added subset species layer e.g.
   nga\_iucn\_selection\_PO.shp in this example and and Click Filter
- b. To only include species which are terrestrial put the following expression into the Query Builder window:



"biome_terr" = 't'	🔏 Query Builder
c. Click Test 🔪	Set provider filter on nga_iucn_selection_PO
d. Click OK to close the Query	Fields Values
Result window	id_no  binomial presence origin comoiler
🔏 Query Result	citation
The where clause returned 4161 row(s).	Sample All Use unfittered layer
e. Click OK to close the Query Builder window	Provider specific filter expression
	OK Test Clear Cancel Help

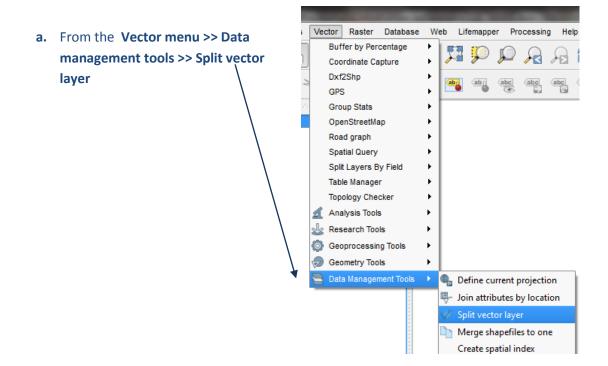
f. Right click on the subset IUCN spatial dataset e.g nga\_iucn\_selection\_PO.shp in this example and Click Save as



g. Save the file with a new name. e.g. nga\_iucn\_selection\_PO\_T.shp in this example

Format	ESRI Shapefile		
Save as	C:/NGA_SpeciesRichness/nga_iucn_se	election_PO_T.shp	Browse
CRS	Layer CRS		
	WGS 84		Browse
Encoding	1	System	T
	only selected features		
	attribute creation saved file to map		

#### 2.2.5. Split the final subset IUCN dataset into separate files by species



 Under input vector layer choose the name of the species range file you want to split. e.g. in this example nga\_iucn\_selection\_PO\_T.shp

c. Under unique ID field choose the field to base the split on. Select id\_no, this contains a unique ID for each species.

	🔏 Split vector layer
	Input vector layor
	nga_iucn_selection_PO_T
	Unique ID field
	Output folder
7	GA_SpeciesRichness/nga_iucn_selection_PO_T_splitsBrowse
	0% OK Close

d. Select an output folder for the split species range files. e.g. in this example
 C:\NGA\_SpeciesRichness\nga\_iucn\_selection\_PO\_T\_splits

e. Click OK -

#### 2.2.6. Batch clip the separate species datasets to area of interest



a. In QGIS 1.8 go to Analysis>>SEXTANTE toolbox (or in QGIS 2.8. Processing menu >>

Note: - there has been significant improvement in QGIS 2.8 in the batch environment and therefore if possible use this rather than QGIS 1.8 which requires some manual filling of the inputs

**b.** In the **search box** at the top of the toolbox, **write clip**.

c. Right click on clip and choose Execute as batch process.

**d.** In the **input layer column**, click on the **'...'** box and select all of the species range files that you want to clip (**use the shift key** to select multiple files).

Parameters Log Help					
Input layer		Clip layer	Clipped	d ii	n (
ıll_ranges_raw_id_no139.0.shp	]			Ye	•
ll_ranges_raw_id_no140.0.shp				Ye	•
_ranges_raw_id_no2045.0.shp				Ye	ŀ
_ranges_raw_id_no2446.0.shp				Ye	ŀ
_ranges_raw_id_no3127.0.shp				Ye	ŀ
ranges raw id no 4273.0.shp				Ye	Ŀ

- e. In the clip layer column, click on the '...' box and select the vector boundary file covering your area of interest.
- **f. Double click** on the **top of the clip layer column**, to fill every cell. (*This is the bit that does not work in QGIS 1.8 and you have to copy and paste the contents into every row*)

**g.** In the **clipped column**, click on the **'…'** box and **select the location** to store your clipped files and **type a new name** e.g. clip.shp (*this will be the name preceding the filename of the clipped files*)

🌠 qgis-bin	<b>h</b> .	In the pop-up box, under Autofill Mode select Fill with parameter
Autofill mode Fill with parameter values V	, <b>i</b> .	values. These parameter values should be set from the input layer.
Parameter to use Input layer	J.	Click <b>OK</b> .
OK Cancel		

k. Click Run

Parameters Log Help	$\rightarrow$	2		-	7
Input layer		Clip layer		Clipped	d in C
Ill_ranges_raw_id_no139.0.shp		iIS_Phil\phil_hex_50km4326.shp		Ill_ranges_raw_id_no139.0.shp	 Ye 👻
ill_ranges_raw_id_no140.0.shp		iIS_Phil\phil_hex_50km4326.shp		Ill_ranges_raw_id_no140.0.shp	 Ye ▼
l_ranges_raw_id_no2045.0.shp		iIS_Phil\phil_hex_50km4326.shp		l_ranges_raw_id_no2045.0.shp	 ¥€ ▼
l_ranges_raw_id_no2446.0.shp		il Phil\phil_hex_50km4326.shp		l_ranges_raw_id_no2446.0.shp	 Ye 🔻
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_ranges_raw_id_no5499.0.shp		JIS_Phil\phil_hax_50km4326.shp		Lranges_raw_id_no5499.0.shp	 Ye 🔻
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					0

#### 2.2.7. Merge individual files back into a single dataset

- a. Remove all layers from your QGIS project
- **b.** Add in all the clipped species shapefiles

Computer Cocar Disk (C:) Vo	ткэра	ce   NGA_Species_richness  nga_iucn_selection_PO_T_clips	▼ ¥ <del>y</del> Sea	rch nga_iucn_selec	10n_PO
Organize 🔻 New folder					
2705 Human and ecosystem service indicators	*	Name	Date modified	Туре	Siz
퉬 UNREDD RETREAT		clipnga_iucn_selection_PO_id_no_22681786.0.shp	11/12/2014 13:07	SHP File	
🚰 Libraries		clipnga_iucn_selection_PO_id_no_22681816.0.shp	11/12/2014 13:07	SHP File	
Documents		clipnga_iucn_selection_PO_id_no_22681861.0.shp	11/12/2014 13:07	SHP File	
Music		clipnga_iucn_selection_PO_id_no_22681865.0.shp	11/12/2014 13:07	SHP File	
Pictures		clipnga_iucn_selection_PO_id_no_22681885.0.shp	11/12/2014 13:07	SHP File	
Videos	=	clipnga_iucn_selection_PO_id_no22682363.0.shp	11/12/2014 13:07	SHP File	
Videos		clipnga_iucn_selection_PO_id_no_22682413.0.shp	11/12/2014 13:07	SHP File	
📕 Computer		clipnga_iucn_selection_PO_id_no22682577.0.shp	11/12/2014 13:07	SHP File	
Local Disk (C:)		clipnga_iucn_selection_PO_id_no_22682609.0.shp	11/12/2014 13:07	SHP File	
		clipnga_iucn_selection_PO_id_no22682621.0.shp	11/12/2014 13:07	SHP File	
□ Local Disk (E:)	Ŧ	٠ ( m			Þ
File <u>n</u> ame:			- ESRI	Shapefiles (*.shp *.:	CLID) -

#### c. Search for merge in the Processing toolbox

	Processing Toolbox	x
$\left( \right)$	merge	3
	GDAL/OGR [34 geoalgorithms]	
	General tools	
	Merge vector layers     SAGA [227 geoalgorithms]	
	Grid - Tools Merge raster layers	
	Shapes Tools     Merge shapes layers	

**d.** Double click on the SAGA **Merge shapes layers** tool. This is the only tool currently available that lets you merge more than two shapefiles at once.

🖉 Merge shapes layers
Parameters Log Help
Main Layer
C:/Workspace/NGA_Species_richness/nga_iucn_selection_PO_T_clips/clipnga_iucn_selection_P( 🕶 🚺 🥥
Additional Layers [optional]
0 elements selected
Merged Layer
[Save to temporary file]
Copen output file after running algorithm
0%
Run Close

e. Click on the ... next to the Main Layer and navigate to the folder containing the clipped shapefiles. Pick the first shapefile in the list e.g. in this example clippga\_iucn\_selection\_PO\_id\_no\_\_219.0.shp

🧭 Main L	Layer		_	x
$\bigcirc \bigcirc$	) ~ 🕌 ≪ NGA_Speci ► nga_iucn_selection_PO_T_clips	✓ Search nga_iu	ucn_selection_PO	2
Organiz	ze 🔻 New folder		;≡ ▼ 🚺 (	?
^ ^	Name	Date modified	Туре	-
	clipnga_iucn_selection_PO_id_no_219.0.shp	11/12/2014 13:08	SHP File	
Π 🕺	clipnga_iucn_selection_PO_id_no10103.0.shp	11/12/2014 13:08	SHP File	
	clipnga_iucn_selection_PO_id_no10109.0.shp	11/12/2014 13:08	SHP File	
	clipnga_iucn_selection_PO_id_no10112.0.shp	11/12/2014 13:08	SHP File	
	clipnga_iucn_selection_PO_id_no10115.0.shp	11/12/2014 13:08	SHP File	-
	٠ III			F.
	File name: clipnga_iucn_selection_PO_id_no_219.0	).sh	)	•
		Open	Cancel	

- f. Click on the ... next to Additional Layers and click Select All
- g. Then untick the layer that you selected as the main layer. E.g. in this example clipnga\_iucn\_selection\_PO\_id\_no\_\_219.0.shp

As we removed all other layers from the table of contents we can click 'select all'. This adds the rest of the species layers which will be merged with the layer chosen as the main layer.

🔏 Multiple selection	? ×
clipnga_iucn_selection_PO_id_no_219.0 [Ef  clipnga_iucn_selection_PO_id_no_1550.0 [E	Select all
<ul> <li>clipnga_iucn_selection_PO_id_no_1793.0 [E</li> <li>clipnga_iucn_selection_PO_id_no_2054.0 [E</li> </ul>	Clear selection
<ul> <li>clipnga_iucn_selection_PO_id_no_2147.0 [E</li> <li>clipnga_iucn_selection_PO_id_no_10032.0 [</li> </ul>	Toggle selection
<ul> <li>clipnga_iucn_selection_PO_id_no_10103.0</li> <li>clipnga_iucn_selection_PO_id_no_10109.0</li> </ul>	ОК
<ul> <li>clipnga_iucn_selection_PO_id_no_10112.0</li> <li>clipnga_iucn_selection_PO_id_no_10115.0</li> </ul>	Cancel
<ul> <li>clipnga_iucn_selection_PO_id_no_10126.0  </li> <li>clipnga_iucn_selection_PO_id_no_10134.0  </li> <li>diamas iwas selection_PO_id_no_10140.0  </li> </ul>	
<ul> <li>clipnga_iucn_selection_PO_id_no_10140.0  </li> <li>clipnga_iucn_selection_PO_id_no_10157.0  </li> <li>clipnga_iucn_selection_PO_id_no_10167.0  </li> </ul>	
<ul> <li>clipnga_iucn_selection_PO_id_no_10274.0  </li> <li>clipnga_iucn_selection_PO_id_no_10282.0  </li> </ul>	
<ul> <li>clipnga_iucn_selection_PO_id_no_10283.0</li> <li>clipnga_iucn_selection_PO_id_no_10283.0</li> <li>clipnga_iucn_selection_PO_id_no_10341.0</li> </ul>	

## h. Click OK

i. Click on the ... next to **Merged Layer** and navigate to an output folder and save the Merged Layer with a new name e.g. in this example **mergedclips\_nga\_iucn\_selection\_PO.shp** 

Save file	Cate						102222
.ook in:	C:\Workspace\WGA_Species_richnes	3	-	00	0		
My Cor Corinna	nga_iucn_selection_PO_T_s						
File <u>n</u> ame:	mergeddips_nga_jucn_selection_PO.shp					Save	
Tiller of homes	SHP files (*.shp)				-	Cancel	I
Files of type:							

Verge shapes layers larameters Log Help			ſ
Main Layer			Ī
C:/Workspace/NGA_Species_richness/nga_iucn_selection_PO_T_clips/clipnga_iucn_selection_PO_id_no219.0.sh			
Additional Layers [optional] 199 elements selected Merged Layer			
C:/Workspace/NGA_Species_richness/mergeddips_nga_jucn_selection_PO.shp			
Open output file after running algorithm			
0%			
	Run	Close	

j. Click Run

#### 2.2.8. Dissolve and convert to single part features

- a. From the main menu click on the Vector>> Geoprocessing Tools>> Dissolve tool
- b. Select the merged IUCN species range dataset for the input layer
- c. Select the species id\_no as the Unique ID field (i.e. the field to dissolve on)
- d. Navigate to the output folder to save the dissolved dataset with a new name e.g. in this example
   C:\Workspace\NGA\_Species\_richness\
   dissolvedmergedclips\_nga\_iucn\_selection\_PO
   .shp

🧭 C	Dissolve	
P	arameters Log Help	
•	Input layer	
	mergedclips_nga_iucn_selection_PO [EPSG:4326]	
	Dissolve all (do not use field)	
	Unique ID field [optional]	
	ID_NO 🔻	Н
	Dissolved	Н
	ichness/dissolvedmergedclips_nga_iucn_selection_PO.shp	
	Open output file after running algorithm	
	0%	
	Run Close	

- e. Next convert the dissolved dataset to single part features (i.e. so that there is one row in the attribute table for every polygon rather than one row for every group of polygons with the same attribute). From the main menu click on the Vector>> Geometry Tools>> Multiparts to singlepart tool
- f. Select the dissolved dataset as the Input Layer e.g. in this example
  C:\Workspace\NGA\_Species\_richness\ dissolvedmergedclips\_nga\_iucn \_selection\_PO .shp
- g. Navigate to the output folder to save the dissolved dataset with a new name e.g. in this example
  C:\Workspace\NGA\_Species\_richness\ SP\_dissolvedmergedclips \_nga\_iucn\_selection\_PO .shp

🔏 Multipart to singleparts	? ×
Input line or polygon vector layer	
dissolvedmergedclips_nga_iucn_selection_PO	•
Output shapefile	
SP_dissolvedmergedclips_nga_jucn_selection_PO.shp	Browse
X Add result to canvas	
0% OK	Close

h. Click OK

 Remove all layers from your QGIS project except the singlepart species dataset generated in the previous step
 e.g. in this example C:\Workspace\NGA\_Species\_richness\SP\_dissolvedmergedclips
 \_nga\_iucn\_selection\_PO .shp

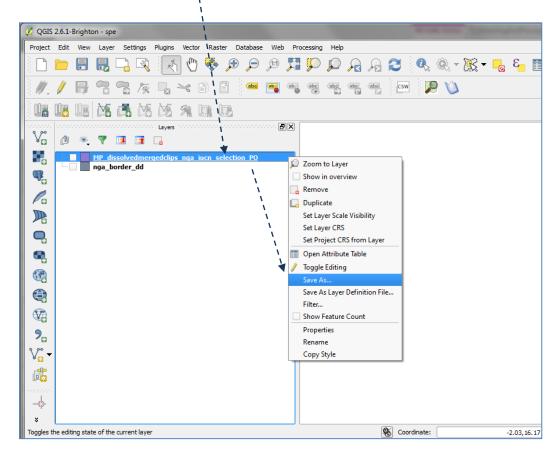
## 2.2.9. Save dataset to an equal area projection

In subsequent steps a layer called a **planning unit layer** will be generated in order to **summarise the species range data to create a species richness map**. The planning unit layer may simply be a regular grid of squares or hexagons across the area of interest or an irregular summary unit for example territories within a country. The species range and the planning units layers must be projected to an equal area projection (e.g. Lambert Azimuthal Equal Area). Using an equal area projection allows the true area of the species ranges in each planning unit to be calculated. Whichever projection is chosen, both the species ranges and the planning units **must** be in exactly the same projection.

In this example, the data are in CRS EPSG:4326 (a geographic coordinate system with units in decimal degrees). In order to generate a planning units dataset of hexagons with a specific area, the data need to be projected into an equal area CRS with units of meters. In the following example Lambert-azimuthal-equal-area projection is used.

*Note: - The there is currently a <u>bug</u> in the project tool in QGIS 2.8 and therefore below we are using the right-click>> save-as option to change the projection* 

There may be an appropriate equal area projection that is already defined within QGIS suitable for your area of interest, or you may have already defined a custom projection. To create a new a custom projection follow the instructions in **Box D**.



a. To project the data Right Click on the singlepart species dataset and Click Save as...

b. Choose Selected CRS and click Browse next to the Save as box to create a new output dataset e.g. SP\_dissolvedmergedclips\_nga\_iucn\_selection\_PO\_la.shp in this example



c. Click on Change to change the output ptojection. In this example we are using a custom Lambert -azimuthal-

Coordinate Reference System Selector

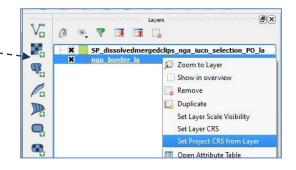
equal-area projection.

- Add the country boundaries shapefile back into QGIS e.g. in this example nga\_border\_dd.shp and repeat the save as step to save it in same equal area projection as your species layer.
- Remove the Geographic version of the datasets from the QGIS project to reduce confusion.

Filter		
Recently used coordinate reference systems		
Coordinate Reference System	Authority ID	
* Generated CRS (+proj=laea +lat_0=-9 +lon_0=36 +x_0=0 +y_0	USER:100001	
North_Pole_Lambert_Azimuthal_Equal_Area	EPSG:102017	
WGS 84 / UTM zone 37S	EPSG:32737	
LA NGA	USER:100003	
WG5 84	03EK.100005	
•		Ľ
<u></u>		_
Coordinate reference systems of the world	Hide deprecated CF	
coordinate reference systems of the world		KSS
Coordinate reference systems of the worka	Authority ID	KSS ▲
	Authority ID	kSs ▲
Coordinate Reference System	Authority ID USER:100006	KSS
Coordinate Reference System * Generated CRS (+ proj=laea + lat_0=-6 + lon_0=34.5 + x_0 * Generated CRS (+ proj=laea + lat_0=-6 + lon_0=34.5 + x_0 * Generated CRS (+ proj=laea + lat_0=-9 + lon_0=36 + x_0=	Authority ID USER:100006 USER:100000 USER:100001	×55
Coordinate Reference System	Authority ID USER:100006 USER:100000 USER:100001 USER:100002	
Coordinate Reference System	Authority ID USER:100006 USER:100000 USER:100001 USER:100002 USER:100002	K55
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Coordinate Reference System      * Generated CRS (+proj=laea +lat_0=-6 +lon_0=34.5 +x_0      * Generated CRS (+proj=laea +lat_0=-6 +lon_0=34.5 +x_0      * Generated CRS (+proj=laea +lat_0=-9 +lon_0=36 +x_0=      Generated CRS (+proj=laea +lat_0=8 +lon_0=9.5 +x_0=      LA_NGA      test	Authority ID USER:100006 USER:100000 USER:100001 USER:100002 USER:100003 USER:100004	
Coordinate Reference System * Generated CRS (+ proj=laea + lat_0=-6 + lon_0=34.5 + x_0 * Generated CRS (+ proj=laea + lat_0=-6 + lon_0=34.5 + x_0 * Generated CRS (+ proj=laea + lat_0=-9 + lon_0=36 + x_0= * Generated CRS (+ proj=laea + lat_0=8 + lon_0=9.5 + x_0= * LA_NGA test	Authority ID USER:100006 USER:100000 USER:100001 USER:100002 USER:100003 USER:100004	
Coordinate Reference System      * Generated CRS (+proj=laea +lat_0=-6 +lon_0=34.5 +x_0      * Generated CRS (+proj=laea +lat_0=-6 +lon_0=34.5 +x_0      * Generated CRS (+proj=laea +lat_0=-9 +lon_0=36 +x_0=      Generated CRS (+proj=laea +lat_0=8 +lon_0=9.5 +x_0=      LA_NGA      test	Authority ID USER:100006 USER:100000 USER:100001 USER:100002 USER:100003 USER:100004	

Select the coordinate reference system for the vector file. The data points will be transformed from the layer coordinate

c. Finally, Right click on one of the layers and Set Project CRS from Layer so that the project projection is now the same as the layers



? X

There should now just 2 files in the project :-

> The projected species single part dataset: e.g.

 ${\it SP\_dissolved} merged clips\_nga\_iucn\_selection\_PO\_la.shp$ 

> The projected country boundary dataset: e.g. **nga\_border\_la.shp** 

1

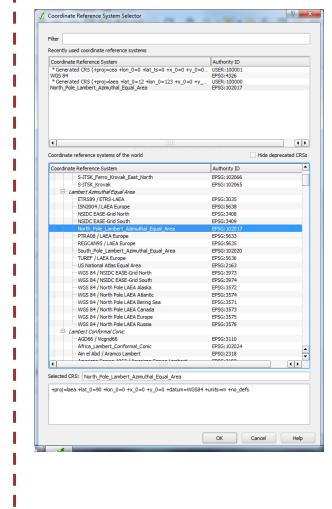
#### Box D

It may be useful (although not always necessary) to create a **custom projection**, for example a Lambert Azimuthal Equal Area projection centred on a particular country or world region. In this example, the projection is centred on the Philippines, with a Central Meridian (longitude of origin) of 123 and a Latitude of Origin of 12. To centre the projection on a different country or region, a different Central Meridian and Latitude of Origin are required.

To create a custom projection, go to the settings menu in QGIS and choose **Custom CRS**. Click **Add new CRS**, and give your projection a name.

Choose the parameters. For a Lambert Azimuthal Equal Area projection, click on **Copy existing CRS**, and select

North\_Pole\_Lambert\_Azimuthal\_Equal\_Area. Click OK.



usion coordin	ate Reference System Definition	?
efine		
/au ann dafina un	our own custom Coordinate Reference System (CRS) here. The definition	an unt
	oj4 format for specifying a CRS.	must
Name	Parameters	
	d +proj=cea +lon_0=0 +lat_ts=0 +x_0=0 +y_0=0 +ellps=WGS84 + d +proj=laea +lat_0=12 +lon_0=123 +x_0=0 +y_0=0 +ellps=WGS8	
(		
🕀 Add new CF	RS	Remove
Name:	new CRS	
Parameters:		
Parameters:		
Сору		
Copy existing CRS		
Copy existing CRS	as helper to test the CDS definition was are meating. Enter a coordinate	where both
Copy existing CRS est Jse the text boxe he lat/long and th	es below to test the CRS definition you are creating. Enter a coordinate the transformed result are known (for example by reading off a map). Th	
Copy existing CRS est Use the text boxe he lat/long and the alculate button to	he transformed result are known (for example by reading off a map). Th to see if the CRS definition you are creating is accurate.	en press the
Copy existing CRS est Jse the text boxe he lat/long and the calculate button to Geographic	he transformed result are known (for example by reading off a map). Th to see if the CRS definition you are creating is accurate.	
Copy existing CRS est Jse the text boxe he lat/long and the laculate button to Geographic North	he transformed result are known (for example by reading off a map). Th to see if the CRS definition you are creating is accurate.	en press the
Copy existing CRS est lase the text boxe he lat/long and ti alculate button to Geographic lorth	he transformed result are known (for example by reading off a map). Th to see if the CRS definition you are creating is accurate.	en press the
Copy existing CRS est Use the text boxe the lat/long and the calculate button to	he transformed result are known (for example by reading off a map). Th to see if the CRS definition you are creating is accurate.	en press the
Copy existing CRS est Jse the text boxe he lat/long and the laculate button to Geographic North	he transformed result are known (for example by reading off a map). Th o see if the CRS definition you are creating is accurate. c / WGS84 Destinal	en press the

Then edit the information in the parameters box to change the central meridian and latitude of origin to centre the projection on a particular country or region. For the Philippines this means setting lat\_0=12 and lon\_0=123. Click **OK**.

	own custom Coordinate Reference System (CRS) here. The definition must format for specifying a CRS.
Name	Parameters
* Generated new CRS new CRS	+proj=cea +don_0=0 +dat_ts=0 + x,0=0 +y_0=0 +y_0=0 +elgs=WGS34 +towgs34 +proj=laea +dat_0=12 +don_0=0 +123 + x_0=0 + y_0=0 +dgatworks34 +towgs34 +proj=laea +dat_0=90 +don_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=
Add new CRS	ew CRS
	+proj=laea +lat_0=12 +lon_0=123 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs
Copy existing CRS	
ne lat/long and the t	velow to test the CRS definition you are creating. Enter a coordinate where both transformed result are known (for example by reading off a map). Then press the ef fhe CRS definition you are creating is accurate. WGS84 Destination CRS
	Calculate
	OK Cancel Help

2.2.10. Check data for topological errors

Check for topological errors in the data as these could prevent the Qmarxan plugin working correctly.

Check for geometry errors in the projected IUCN and the country boundaries shapefiles

j. From the vector menu click **Geometry Tools>>Check geometry validity**. Run for **both** dataset. (Remember to click **OK** to run the tool) /



Check geometry validity	
Input Vector Layer	<b>k.</b> In this example the country
nga_border_la	boundaries file reported 0
Use only selected features	errors
Geometry errors	Chors
Feature Error(s)	
	Check geometry validity
	Input Vector Layer
	SP_dissolvedmergedclips_nga_iucn_selection_PO_la
Total encountered errors	Use only selected features
Press Ctrl+C to copy results to the dipboard	Geometry errors
Save errors location	Feature Error(s)
Output point shapefile	17 line 0 contains 1 duplicate node(s) at 189
Browse	17 Geometry has 1 errors.
	28 line 0 contains 1 duplicate node(s) at 49
Add result to canvas	28 Geometry has 1 errors. 64 line 0 contains 1 duplicate node(s) at 450
0K Close	Geometry has 1 errors.
	Total encountered errors 40
	Press Ctrl+C to copy results to the clipboard
BUT In the IUCN data there are some	Save errors location
errors to fix.	Output point shapefile
	Browse
Note the <b>Feature Ids</b> that contain errors.	Add result to canvas
These refer to the record id's of the	100% OK Close
polygons in the spatial dataset	

If errors are reported continue to step 2.2.11, otherwise go straight to section 2.3

### 2.2.11. Clean the dataset to remove the errors

#### Search for **clean** in the processing toolbox

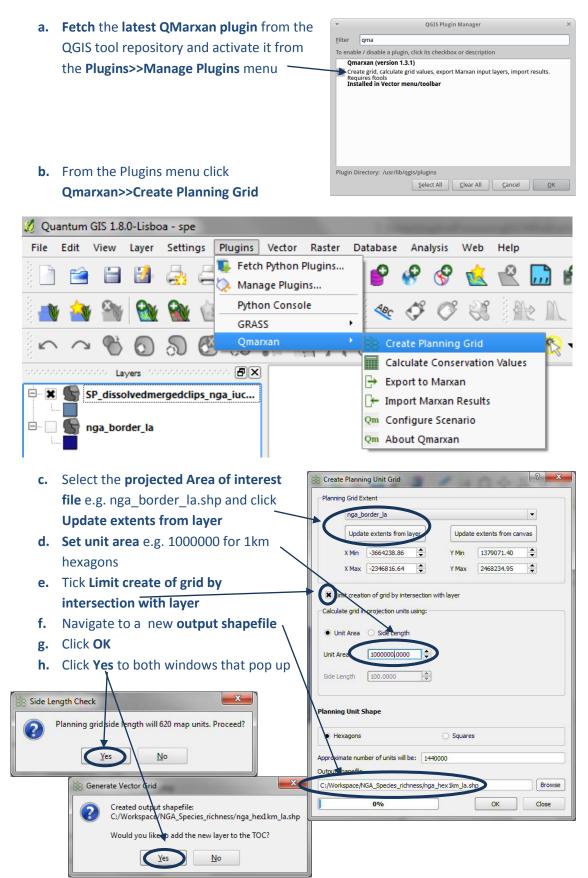
dean
<ul> <li>Recently used algorithms</li> <li>W.dean.advanced - Toolset for cleaning topology of vector map (Advanced).</li> <li>W GRASS commands [168 geoalgorithms]</li> <li>Vector (v.*)</li> <li>V.dean - Toolset for cleaning topology of vector map.</li> </ul>
v.clean.advanced - Toolset for cleaning topology of vector map (Advanced).

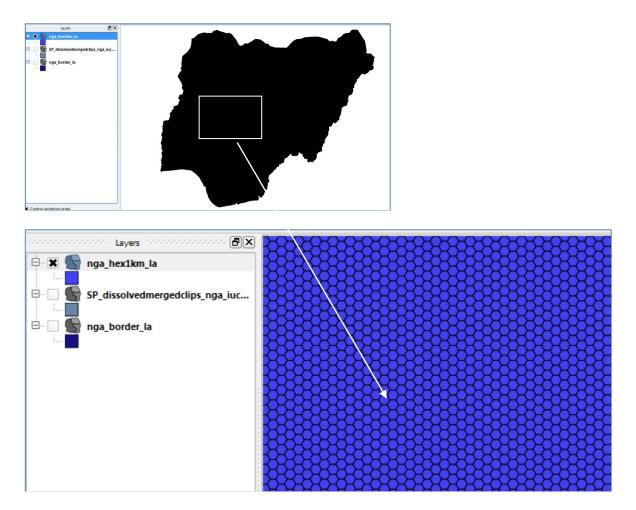
## Double click on the **v.clean.advanced** tool

SP_dissolvedmergedclips_nga_iucn_selection_PO_la [USER: 100007]		ſ
or Cappendering Gereinbergenergenergenergenergenergenergenerg	(	<b>)</b>
Cleaning tools (comma separated)		
break		
Threshold		
0.000100	<b>.</b>	
GRASS region extent (xmin, xmax, ymin, ymax)		
-3664238.8599,-2346816.63681,1379071.40258,2468234.9546		
Cleaned vector layer		
C:/Workspace/NGA_Species_richness/SP_dissolvedmergeddips_nga_iucn_selection_PO_ladeaned.shp		
🗶 Open output file after running algorithm		
Errors layer		
C:/Workspace/NGA_Species_richness/SP_dissolvedmergedclips_nga_iucn_selection_PO_la_error.shp		]
Open output file after running algorithm		
		Ċ
0%		
Run		Close

Note: If the dataset is very large and QGIS is failing to clean the dataset the clean tool can be run in the native GRASS interface. Some guidance notes are provided in the Annex for cleaning a dataset natively in GRASS.

- 2.3. Vector analysis to create species richness (in QGIS 1.8 only as requires QMarxan plugin)
  - 2.3.1. Generate a dataset of hexagons or squares using the Qmarxan plugin

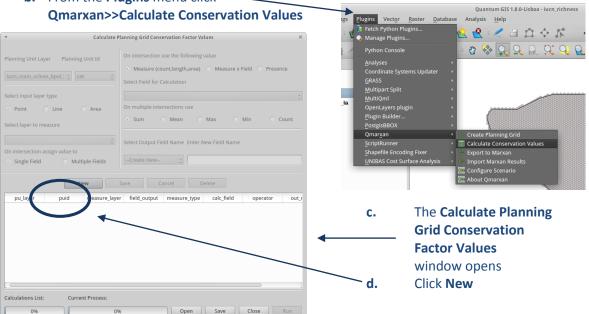




i. Zoom in to check that the hexagons have been created correctly

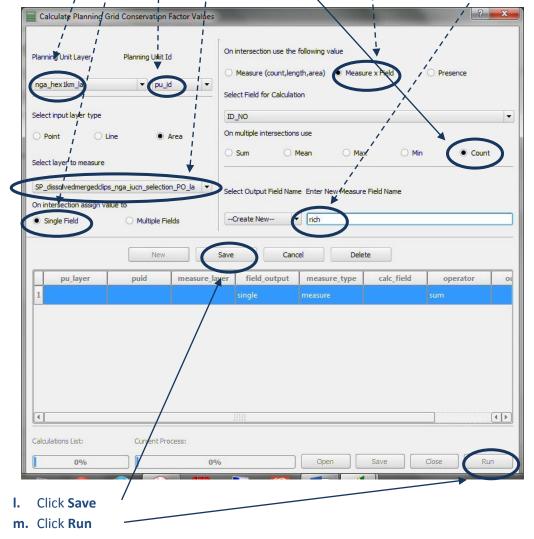
## 2.3.2. Generate species richness using the Qmarxan plugin

a. The next step is to use the planning units file to generate a count of number of threatened species in each planning unit hexagon



**b.** From the **Plugins** menu click

- e. Select the Planning Unit Layer generated in the previous step
- f. Select the **Planning Unit Id** (this is unique ID for each hexagon in the planning units dataset upor which the summaries will be made)
- g. Set On intersection assign value to Single field
- h. Set the On intersection use the following value to Measure X Field
- i. Set the Select Field for Calculation to either the species ID or binomial
- j. Set the **On multiple operations use** to **Count**
- k. Set the new Output Field Name to be added to the planning units e.g. mam



#### 2.3.3. Check any errors located in the error log and spot-check for quality control

 qcalc\_20131122T110141\_err.log - Notepad

 File
 Edit
 Format
 View
 Help

 measure\_layer:
 G:\iucn\iucn\_mam\_vclean\_bpol\_la.shp
 field\_output:
 field\_output:

 field\_output:
 single
 measure\_calculation\_field:
 operator:
 count

 output\_name:
 mam
 measure\_layer;
 examination of the below PU layer features is necessary.
 spatially coincident features in measure layer may be the cause of the error.

 1332;
 1332;
 1332;
 1332;

 1332;
 1332;
 1332;

 1332;
 1332;
 1332;

 1332;
 1332;
 1332;

 a) In the Planning Units folder
 open the error log generated by the previous step

For each of the planning units listed manually check the results of the features listed

- b) Right Click on the Planning Unit Layer and open the attribute table
- c) Select the PU and zoom to it in the map canvas
- d) Click on the IUCN species layer in the table of contents
- e) Then Click on the Select Features by Polygon tool and draw a polygon around the hexagon (PU) to select features within the IUCN dataset corresponding to that hexagon

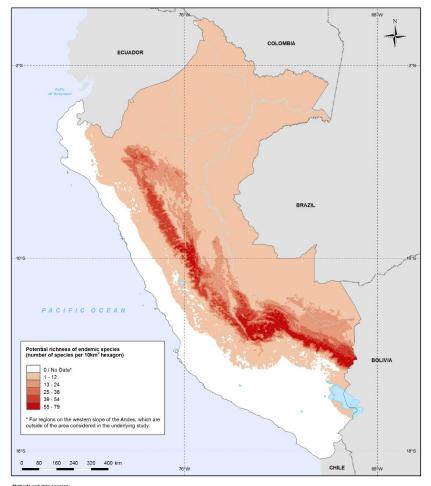
🕀 🗖 📾 🖬 🖉 🛔
😤 Select Single Feature
段 Select Features by Rectangle
😥 Select Features by Polygon
😥 Select Features by Freehand
😪 Select Features by Radius

f) The number selected should match with the count in the 'mam' field in the Planning Unit Layer. Check again by drawing the polygon around the hexagon and if necessary alter the value in the 'mam' field to match the number selected

This is the final species richness dataset.

The dataset can then be symbolized and placed in a map layout as in the example below Below is an Example map output

#### **Example Map**



Enclands upschaft auf hours (an aphblans, mammals and brinds): Young UE: Back's (Corkora J. Emchert D. Francis I. Henzods P. Hezzog S. Pacheco V. Timaná M. Tovar C, and Vargas J. 2007. Digital distribution most of packets indimication to the and stop of the Anders in Peru and Bolins. NatureSever Data provided by NatureSever in collaboration with the Centro de Dato para la Conservación (CCC) of the Universidad Nacional Agrantia La Moltan. The Maeso de Historia Naturala de la Universidad Major Jaca Introduced by NatureSever in collaboration with the Centro de Dato para la Conservación (CCC) of the Universidad Nacional Agrantia La Maina. The Maeso de Historia Naturala de la Universidad Major Jaca Introduced and many patricipant patrial haldory museum and Interiani. Sec NatureSever in operative Dato Interial de La Universidad Major.

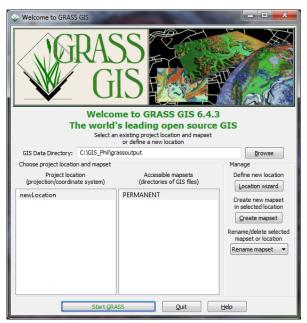
#### Annex1 : Cleaning the topology using GRASS GIS

GRASS GIS works best as a standalone programme, although it does have a QGIS plug-in, so many of the GRASS tools are also available in QGIS. *You may have used the GRASS v.clean tool from within in QGIS)*. This example runs through cleaning of the IUCN data which can be a very large dataset depedning on your area of interest and how many species you are working with. The standalone version of GRASS is automatically installed when you install QGIS.

a. Click on Education>>GRASS GIS to open GRASS

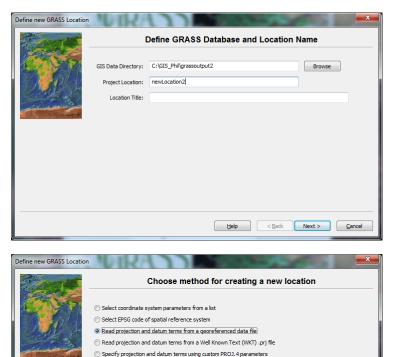
To use GRASS as a standalone programme, it is necessary to set the **project location** and **mapset**.

- b. Click on the Location Wizard and choose the location of the GIS data directory, plus a folder name for the project location.
   For faster computation, choose a location on your local drive and avoid spaces in folder names.
- c. Click on Start Grass



Click Next

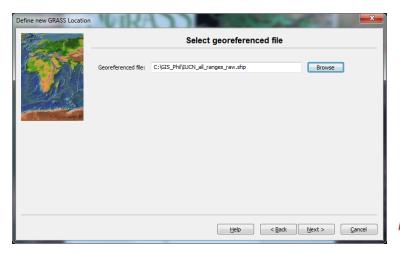
d.



 Help
 < Back</th>
 Next >
 Cancel

Create a generic Cartesian coordinate system (XY)

- e. Choose the option Read projection and datum terms from a georeferenced data file
- f. Click Next



- **g. Select** the shapefile containing the clipped and projected species range data with the topological errors.
- h. Click Next
- i. Click Finish
- j. Click OK

Wait for GRASS to create the new project location.

Now import the species range data.

 In the GRASS GIS Layer Manager, go to the File menu >> Import vector data >> Common import formats [v.in.ogr]

Settings Raster Vector Imagery Volum	s Database Help
Workspace Map display	
Import raster data	•
Import vector data	Common import formats [v.in.ogr]
Import 3D ratet data Import databaset table Export rester map Export source map Export 3D raster maps Export databaset table Link external formats Manage maps and volumes Map type conversions	ASCII points/GRASS ASCII vector import [vi.n.ascii] ASCII points as vector import [vi.n.lines] Historical GRASS vector import [v.convert] Historical GRASS vector import [all maps] [v.convert.all] DXF import [vi.n.ddf] WFS [vi.n.wfs] ESRI e00 import [vi.n.garmin]
Georectify	GPSBabel GPS import [v.in.gpsbabel] Geonames import [v.in.geonames]
Graphical modeler Run model	GEOnet import [vin.gns] Matlab array or Mapgen format import [vin.mapgen]
NVIZ (requires Tcl/Tk) [nviz] 3D image rendering [m.nviz.image]	
Bearing/distance to coordinates [m.cogo]	
Cartographic Composer [ps.map]	a
Launch script	GR. 92:32:31.56W; 20:34:13.765
Exit GUI	Ctrl+O

- Click Browse to choose the shapefile containing the clipped and projected species ranges. Under options select the option extend region extents based on new dataset.
- m. Click Import.

A range of cleaning processes will be automatically undertaken during the import process. **This could take** several hours depending on the size of the file being imported.

Settings			
oad settings.	:	•	Save Remove
Source type			
File	○ Directory ○ Database ○ Pro	stocol	
Source setti	ngs		
format:	ESRI Shapefile	•	
ile:	C:\GIS_Phil\IUCN_all_ranges_ra	w.shp	Browse
List of OGR	layers		
Layer id		Name for GRASS map (editable	)
	Layer name	Nume for GRASS map (carable,	<b>,</b>
☑ 1	Layer name IUCN_all_ranges_raw	IUCN_all_ranges_raw	2
Options Do not de	IUCN_all_ranges_raw	IUCN_all_ranges_raw	-
Options Do not de Vextend ret Override Change co Do not cre Change co Create 3D	an polygons (not recommended) gion extents based on new dataset lataset projection (use bication's proj tate attribute table Jumn names to lowercase characters output	IUCN_all_ranges_raw	*
Options Do not de Extend rec Extend rec Override c Limit impor Do not cre Change cc Create 3D Allow outpu	an polygons (not recommended) gion extents based on new dataset Jataset projection (use location's proj t to the current region axte attribute table Jumn names to lowercase characters	IUCN_all_ranges_raw	, 

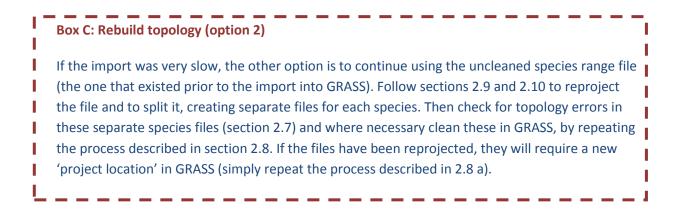
- When the import is complete, check the command console in the GRASS GIS Layer Manager.
- o. If there is no warning message you can go straight to step p and simply export the file from GRASS.

If there is a **warning message** (see screenshot), the next step is to use the **v.build** procedure to **rebuild the topology** (see Box A: Rebuild topology below)

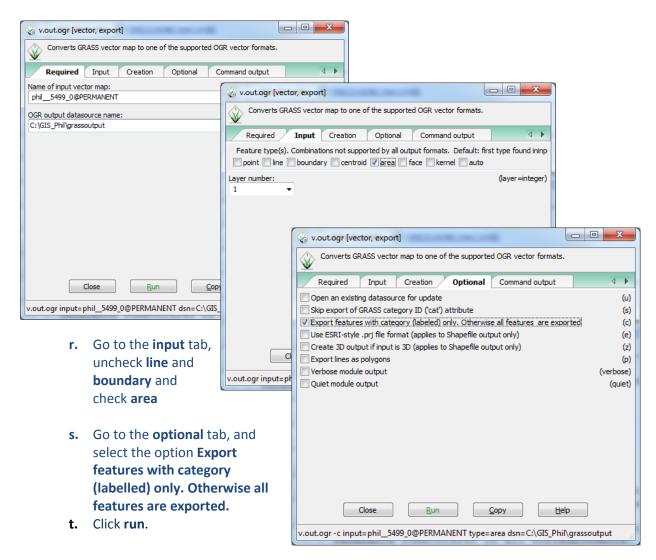
♦ GRASS GIS Layer Manager
<u>File Settings Raster Vector Imagery Volumes Database Help</u>
▏▖▖▖▖▖▖▖ ▎▎▋▐▖▆⋕⋧⋻▏᠅◇
Click here to show search module engine >>
Attaching centroids Number of nodes: 10 Number of primitives: 13 Number of points: 0 Number of lines: 0 Number of boundaries: 9 Number of centroids: 4 Number of areas: 5 Number of isles: 2 Number of areas without centroid: 1
WARNING: Errors were encountered during the import Try to import again, snapping with at least 1e-014: 'snap= Default region for this location updated Region for the current mapset updated (Thu Feb 27 12:18:20 2014) Command finished (0 sec)
<
Output window Command prompt Clear Save Log file Clear Stop
Map layers Command console Search module Python shell

Bo	x A: Rebuild topology	v.build [vector, topology]       Creates topology for GRASS vector map.
a.	In GRASS GIS go to the Vector menu >> Topology maintenance >> Create or rebuild topology [v.build].	Required     Optional     Command output     Manual     Image: Manual       Name of input vector map:     (map=name)       phil_5499_0@PERMANENT     Image: Manual
	Make sure name of <b>input vector</b> <b>map shows your file</b> (it will have <b>@PERMANENT</b> at the end of the file name)	
b.	Click <b>Run</b> .	Close Run Copy Help
c.	Check the <b>command console</b> to find the results of the v.build. <b>If</b> <b>there is no warning message</b> you	Image: Close dialog on finish
lf t	can now export the file from GRASS (g	

time setting a snapping threshold.	<ul> <li>a. To re-import the file into GRASS, but this</li> <li>a. To re-import the file and set a snapping threshold, go back to [v.in.ogr], as in step k, but this time inlude an additional step and click Command dialog</li> <li>b. In the new window, browse to find your species range file, and select a name for output vector map (the name of the new file</li> </ul>
Options       Op not clean polygons (not recommended)         V Extend region extents based on new dataset       Override dataset projection (use location's projection)         Umit import to the current region       Do not create attribute table         Change column names to lowercase characters       Create 3D output         Allow output files to overwrite existing files       V Add imported layers into layer tree         Close dialog on finish       Command dialog	within GRASS)
Go to the Min-area & snap tab. Write '1e-014' as the snapping threshold. It is important to set a low threshold, otherwise snapping can introduce errors. If the distance between two points is lower than the snapping threshold, these points will be assumed to be in the same place. This can correct many topological errors, but it can also cause errors if the snapping threshold is set too high. Even with a very low threshold it is still possible to introduce errors, and you will later need to check that the cleaned species ranges match the original ranges.	Load Save As Name for output vector map: UCNL al ranges raw.id.ro_139 Close Run Copy Help Add created map(s) into layer tree Close dialog on finish v.in.ogr dsn=C:\GIS_Phil\indrangeerrors\IUCN_all_ranges_raw_id_no_139.shp output=IUCN v.in.ogr [vector, import] v Convert OGR vector layers to GRASS vector map. Required Selection Subregion Min-area & snap Attributes V Minimum size of area to be imported (square units): (min_area=float 0.0001 Snapping threshold for boundaries: (snap=float 1e-014
<ul> <li>Click <b>run</b> and wait for the import to complete. Again, this may take some time.</li> <li>Then go <b>step (p)</b> to export the cleaned data from GRASS GIS.</li> </ul>	Close <u>Run</u> <u>Copy</u> <u>Help</u> Add created map(s) into layer tree Close dialog on finish



- p. To export the file from GRASS, go to the File menu >> Export vector map > >Common export formats [v.out.ogr]
- **q.** Select the name of the file you want to export (it will have **@PERMANENT** at the end of the file name) and under **OGR output datasource name** write the file path of the chosen export location.



🗞 v.out.ogr [vector, export]					
Converts GRASS vector map to one of the supported OGR vector formats.					
Required Input Creation Optional Command output					
(Thu Feb 27 14:08:48 2014)					
v.out.ogr -c input=phil_5499_0@PERMANENT type=area dsn=C:\G					
Exporting 5 areas (may take some time) WARNING: 1 features found without category were skipped					
v.out.ogr complete. 5 features written to <phil 0="" 5499=""> (ES)</phil>					
(Thu Feb 27 14:08:50 2014) Command finished (2 sec)					
۲ ۲					
Output window Command prompt					
<u>C</u> lear Stop					
Close <u>R</u> un <u>C</u> opy <u>H</u> elp					
v.out.ogr -c input=phil_5499_0@PERMANENT type=area dsn=C:\GIS_Phil\grassoutput					

In the command output, ignore any warnings that features found without category were skipped.

u. Close GRASS.

- v. Open QGIS and add the cleaned file that you exported from GRASS.
- w. Use the 'Add Vector layer button.
- **x.** Check whether any **topological errors** remain (see section 2.7).

Make note of the species that are <u>still</u> affected by these errors, you may need to check these manually and select them out and clean them on their own.