MICHAEL ANDERSON – 29380411
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Tasks: Readings of “Extinction Risk from Climate Change” paper, *Python Scripting* Chapter 1&2 (with exercises), and *Saving a Million Species* part 1

READINGS AND EXERCISES

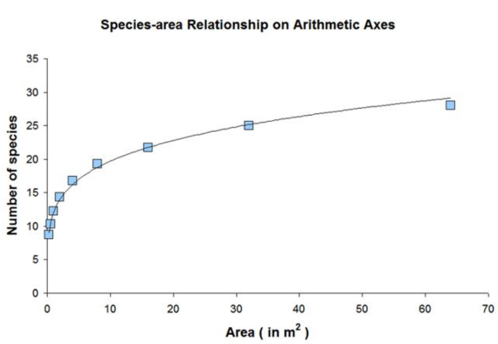
One of the books I’ll be reading, *Saving a Million Species from Extinction*, by Chris Thomas, is a large expansion of a 2004 research paper by the same author. This paper, “Extinction Risk from Climate Change,” is the first paper I’ll be reading for my study.

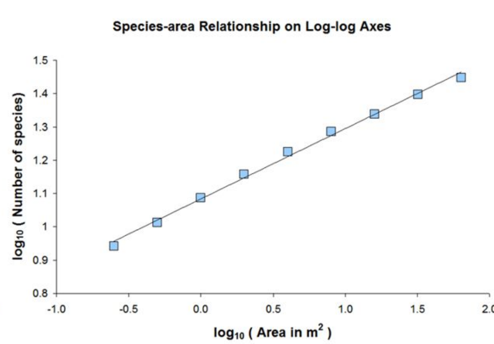
Extinction Risk from Climate Change – Thomas et al 2004 - https://www.nature.com/articles/nature02121

Description of text:

Climate change from greenhouse gas emission is likely to make the planet warmer than any time within the past 20 million years, and at an unnaturally high rate, shifting the ranges of many species. This study projects the future distributions of over 1,000 species using respective “climate envelopes” which are compared to future estimates and conditions. These envelopes are made up of climate data, such as precipitation and temperature, as well as current distribution data for the given species. The study looks to see if these “envelopes” can be retained in future estimates, and operates two scenarios for every species: unlimited dispersal (species can migrate) and no dispersal (static). Only these two extremes are used, although the author(s) mention that most species will be somewhere in the middle.

Extinction is estimated using the formula $S = cA^z$, where S = number of species, A = land area of the species, z is the slope of the species/area relation in log-log space (meaning that the graph uses logarithmic scales), and c is a constant for the number of species that would populate one given square unit of space. On a log-log graph, the relationship is a straight line, regular graphs have the familiar species-area curve. Examples shown below.





Source: https://en.wikipedia.org/wiki/Species-area_relationship

The study uses z=.25 - the authors cite it as an accurate value in most cases. Three different methods were used to estimate habitat/area changes and extinction. The first uses net change in distribution across all species (summed as a whole), the second uses average proportional loss to each species’ range, and the third estimates each species extinction risk then averages this out to get regional extinction estimates. This was the most confusing aspect of the study – I’ve set up an Excel table below that shows the equations used.

Equation	Description
$E_1 = 1 - (\Sigma A_{new} / \Sigma A_{original})^z$	A(original) = initial area of a species, A(new) = future projected area
$E_2 = 1 - \{(1/n)[\Sigma (A_{new}/A_{original})]\}^z$	A(new)/A(original) = proportional dist. change, n = # species
$E_3 = (1/n) \ \Sigma \ [1 - (A_{new}/A_{original})]^z$	Regional estimate averaging across species

The study concluded that, averaging the three methods, 18% extinction is expected at minimum, 24% in the mid-range, and 35% as the maximum value by 2050.

Applications for my study:

The “climate envelope” method seems to be central to future estimations, so it would be beneficial if I constructed a climate envelope for the American Pika for my future projects. Additionally, the species/area relation would be a relatively simple starting point for any species loss / extinction estimations that I construct.

Python Scripting Chapter 1 & 2

The lessons in this book are meant for ArcGIS Desktop, but I’ll be doing them in ArcGIS Pro. ArcGIS Pro is more streamlined, operates faster, and uses Python 3 instead of Python 2. The one issue I’m expecting to run into are differences that come with Python 2.x vs Python 3.x, but this is mostly a syntax issue that I should be able to notice or fix when errors are thrown.

The first exercise went through four ways to do a clipping analysis: using the toolbox directly, using a batch, using a model created in the model builder, and using a line of python code.

The first method I wrote does a clip analysis:

```
import arcpy
from arcpy import *

def clipExample():
	env.workspace = "C:/EsriPress/Python/Data/Exercise02"
	arcpy.Clip_analysis("lakes.shp", "basin.shp", "Results/lakes_myClip1.shp")
```

The chapter also went over how to create a script toolbox and how to turn a model from the model builder into a script.

Saving a Million Species Part 1

>>> Part one of the book goes into detail about the uncertainty of climate models, and offers a reflective critique of the methods used in the original 2004 research paper. Species distribution models are not an exact science, and rely on global climate models (GCMs) which include volatile factors such as precipitation estimates. Other factors like human development/usage of habitat can also be difficult to estimate.

>>> Species distribution modeling is described in this section. The first step in the process is associating species records to geographic/climatic variation. The goal is to associate the species with climate variables, so that by using future climate predictions you can predict where ideal conditions for a species will exist in the future. An “overlap zone” between current distributions and predicted distributions is beneficial for the survival of a species, since less migration is necessary. Mountain cases where a species must go higher to find suitable habitat are described as shrinking subsets - this is the situation of the American Pika.

GIS PRACTICE: PIKA HABITAT ELEVATION

This week I associated data between two rasters: pika habitat in the Sierra-Nevada and elevation. I cut the rasters, converted them to shapefiles, made sure the data was correctly associated (for the elevation shapefile) and isolated elevation polygons that had pika habitat within them as a final result. I then exported the elevation data to Google Sheets, where I got the average elevation of pika habitat in the range (2682 m) with a minimum of 1219 m and a maximum of 4314 m. I'd like to look at how this pika habitat relates to temperature conditions as well.