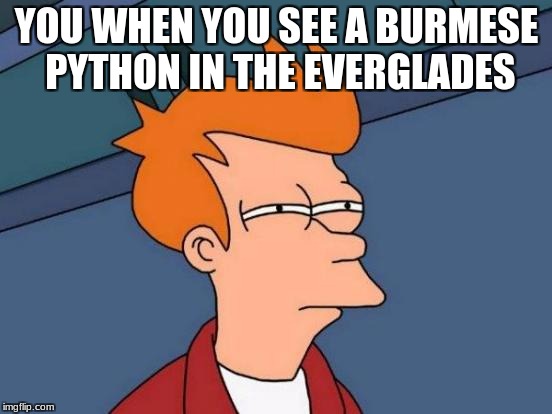
*********Burmese Pythons in Southern Florida Project Proposal 1***

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**Introduction**

When I was living in Australia and New Zealand, one of the major concerns of those countries were invasive species being introduced and impacting native flora and fauna populations. Rabbits and Cane Toads create extra food and habitation competition for Australian mammals and amphibians, while weasels and stoats in New Zealand ricked wiping out the bird population that had no defenses against those predators. Considering they are island nations with delicate ecosystems, Australia and New Zealand dedicate wildlife resources to curb and control invasive species populations. One can witness these programs in place even on popular nature walks through out the two countries, with traps and cages set up to find these pests.

I never took much thought of invasive species until seeing the effort Australia and New Zealand made throughout my time there, when I moved after my undergraduate degree. Growing up in Northern New Jersey, the only real invasive species I witnessed were the stink bugs that always seemed to come out in the summer, and even then, I only really thought of them as a nuisance more than harm to the local environment. When I came back to the United States this past year, I decided to find out more on invasive species in America that are currently becoming a major issue, and unfortunately found out that its not only retirees making Florida home, but also Burmese Pythons. First spotted in 1979, the Burmese Python population had boomed in the past 20 years. Now, the fragile everglades ecosystem is at risk, due to the python’s voracious appetite and breeding skills, in a region that never had snakes of this magnitude in its evolution.

In 2017, Florida introduced a bounty system, where registered and certified hunters can catch Burmese pythons, and get paid depending on the size of the python. I find this an interesting method to combat the spread and population of the pythons, only because Great Britain introduced a very similar program during their rule in India to fight against an increasing population of cobras. This led to an increase in cobra populations, for hunters were releasing cobras into the wild to be caught and paid for, increasing the amount of money they got. It incentivized hunters to not completely wipe out their source of income, for why would they want to get rid of the snakes if they were getting paid for catching/killing them? This has led me to think are there different or better ways to identify and combat the spread of Burmese pythons?

**Project Questions**

Research background questions: Where are pythons being spotted? Has it spread out from the everglades, and into what regions? Why are they spreading into those areas? What’s been the spread throughout the years?

MAIN QUESTION: Can I predict where the population will expand to, to create methods to catch/identify in those areas to help curb the spread? If I can identify/predict where the population is growing geographically, can resources be used to curb the growth and contain it in those predicted areas?

* Can I use the number of sightings and where they are being spotted, to try and make an accurate prediction of the probability a specific section of land will have a Burmese python in it or not?
* Can I use the diet of captured Burmese pythons in Florida to see what animals they are eating (specifically birds and mammals) then look at the migratory or recorded sightings of these animals to see if there is a spatial shift in their population, and if this shift is occurring, do the pythons follow that shift? 🡨can this be a method of predicting where they are moving towards?
* Is there a relationship between the spread of python population and location of human urban and suburban areas?
* What variables have a significance to where pythons are being found? Can these variables be used to predict where they are moving towards?

**Is the Question Causal or Descriptive?**

I’m not sure yet on the answer to this, because I want to look descriptively at where the pythons are now and the relationship to where they’re being sighted (i.e., human areas or prey distribution) but I’m also looking to do causal to see if there is an affect on the expanding population distribution.

**(Brief) Summary of existing relevant research**

In 2011, researchers in the Wilson Journal of Ornithology published a report on the birds consumed by the invasive Burmese Python, the first report detailing the avian diet of the snakes. I plan on using a sample of these bird species to see if they exist outside the everglades and what they’re distribution is like to assess any similarities with Python sightings.

<https://meridian.allenpress.com/wjo/article-abstract/123/1/126/129286/Birds-Consumed-by-the-Invasive-Burmese-Python>

In 2016, the Wetland and Aquatic Research Center published a report that current industry methods for detection and control provide low detection rates, with the methods being detector dogs, remote sensing, attractant traps, judas snakes (methods currently used by hunters, in addition to old fashioned walking and searching) However, Environmental DNA is a promising method of detection, which works by detecting discarded DNA material (skin, droppings) in water, collecting those water samples, and then testing for that python DNA to determine if snakes are present in those areas, which helps to pinpoint specific areas to search for pythons in.

<https://www.usgs.gov/centers/wetland-and-aquatic-research-center/science/using-environmental-dna-burmese-python>

Current tools and techniques for detection seem to focus mainly on finding where the snakes are through physical evidence, yet Burmese pythons are elusive and camouflaged animals. Maybe the process needs to be identifying what attracts pythons to where they are and seeing if there are different variables that have a relationship in where pythons are being spotted.

**Datasets Identified – so far!**

I will be using this site that records all Burmese python sightings in the United States (provides long/lat in a CSV along with Shapefiles). This site also provides animal sighting of the prey species that I will look for spatial patterns as well

<https://www.eddmaps.org/florida/distribution/viewmap.cfm?sub=20461>

<https://www.eddmaps.org/distribution/>

I’ve also collected the following datasets/information from the Florida Geospatial Open Data <https://geodata.floridagio.gov/>

1. Flowing Waters and Stream sites
2. Lakes
3. Bird Habitats 2003
4. Designated Bird Sanctuaries
5. Eagle Nesting Sites
6. Bird Nests 2000
7. Land Mammal Habitation areas
8. Shorebird habitats
9. Snowy Plover Nests
10. Wading Bird Colonies
11. Land Use Cover
12. Temperature/Solar Radiation in TIF format – still need to review
13. Environmental DNA sampling sites

My goal is to assess the spatial relationship between python sightings and potential prey animal’s sights, temperature data (i.e. areas that receive more sunlight/water and areas identified as the warmest) and potentially see how it compares to environmental DNA sampling sites.

**High-Level Summary of Methods**

Currently I can just think of some of the modeling learnt last semester, such a spatial lag or spatial error models to assess relationships between variables but might focus on a logistic model to look at predicting if a python exists in a certain area of not. I can split a dataset and train on the probability a specific plot of land (might split it up not grids or cells) has a python population. Maybe having the prediction on python population probability can help concentrate local efforts on identification and spotting, and so not to waste time and effort in areas that have low probability.

I was thinking about using a random forest in Python (lol the irony) to try and predict/identify areas in which the overall Burmese python population might expand into, i.e., areas of increasing concern. Here I was going to see if the prey animals sightings have changed over the years into different areas away from Burmese pythons (and if the Burmese pythons will follow), or if there is only total overlap amongst prey dispersion and Burmese python dispersion) which renders this moot.

**Describe Deliverables**

1. A prediction model that can identify plots of land/grids that are to have high probability of Burmese pythons existing, and therefore a better tool for scientists and conservationists to find Burmese Pythons in Florida?
2. A model that also predicts the most likely areas that Burmese pythons will spread out into, from where they are currently? This can help organizations to first stop the snakes from expanding, and then work on eradicating.

**How will this be used**

I’m thinking of a research paper, first really brief on why the snakes are harmful to the ecosystem and the cost, current methods of detection and if they are low or high rate of success, and then the model predicting where they can be currently, and where they are most likely to be expanding to. I want to provide those who are trying to catch and contain the Burmese pythons, a tool for better detection, to not waste time and energy in places that don’t have the snake and the reliance on acting through spotting. If I can provide a model that has an accurate probability in detecting pythons and where they are, then resources (time, money, people) can be allocated more effectively and efficiently.

**Problematic Areas to address**

I need to sort out a human index, factoring in how to represent human interactions in collecting and finding pythons. All points of data have involved active human searching. The dataset identifies how the python was found, either through GPS data, google earth, ARCGIS, or physical sighting. I’m thinking of currently parsing through the data to categorize how the python was found and assess weights to each category. Active searching and finding a python can carry a human index weight greater than that of a technological based approach. Remote sensing and GPS can have a lower human index weight, but potentially a higher technological weight?

There are also single individuals reported who found a python, versus the Florida Fish and Wildlife Conservation Commission when finding a python. The commission can have a greater human factor involvement than a single individual spotting.

**Exploratory Data on the Python Sightings**

As of Jan 17th 2022 when this file was downloaded, there are 7,591 pythons reported in the state of Florida, starting from 1979 when the first spotting occurred.

Graphical user interface, text, application

Description automatically generated

**7591 Pythons Sightings by Jan 17th, 2022**

**Map

Description automatically generated**

7591 Python Sightings plotted against the counties map of Florida. Most of the pythons are centered in the south, which makes sense considering that the first pythons were released in the Everglades, which are in the south. Points in the north indicate that the population has been moving northward, so is there a relationship to how this trend compared to other animals, human factors, weather, etc?

**Pythons Sighted pre 2000 – only 13 python sightings, centered in the south**

Map

Description automatically generated

**Pythons Sighted pre 2005 – the number has jumped to 196 pythons sighted. One lone python spotted in Northern Florida.**

Map

Description automatically generated

**Pythons Sighted pre 2010 – the number has exploded to a total of 1161 pythons sighted since 1979. Is this due to a population breeding freely in a predator free environment, or are there more active search attempts for pythons?**

Map

Description automatically generated

You can see on the map that more pythons have made their way into the Florida Keys, along with up north. I will have to dive deeper into the data to see if the recorder put information down on their belief if these pythons are wild born or behaving as recently released pets. The cluster however is still very much down in South Florida. Again, is this spotting due to the large human population in the south having a higher chance of running into the Pythons, or are the pythons finding new sources of food or warmth?

**Pythons Sighted pre 2015 – 2,279 total pythons sighted now. A python has even been observed across states lines and been found in Georgia.**

Map

Description automatically generated

**At the start of 2020, there have been a total of 6,054 pythons sighted since 1979, with 3,775 sighted between 2015 and 2020, the most in a five-year span since 2020.**

Map

Description automatically generated

Why is this a problem? –Are the higher number of pythons sighted indicating a growing population, or is it due to increased vigilance, i.e., we are finding more because we have increased our search attempts? There is no clear answer to this question, because of the issue raised earlier; we only know of where pythons are through being spotted, and not the total number of pythons in the population. Thus, this makes estimating python populations hard.

Chart, line chart

Description automatically generated

The chart above is from a study done by John Willson, Michael Dorcas and Ray Snow in 2010 for the Biological Invasions journal[[1]](#footnote-1). This is just one of their models, projecting the growth of the Burmese python population in Florida with different first year survival percentages of hatchlings, and the estimated range is anywhere from 10,000 to 100,000 in different time spans.

**Initial Data Analysis – Feature Engineering method so far to date**

This next part shows the current work in progress of feature engineering, and in this case is a point-to-point progression of work. I have a dataset of Shore Bird habitats from the Florida Open Geospatial Database, which is plotted below. Next to it is the plot of python sightings in Florida as well. I will use a nearest neighbor function to find the closet shorebird habitat to a python sighting and use haversine distance because it gets the distance between points in meters.

Graphical user interface, chart, scatter chart

Description automatically generated

The distance between the python points and shore bird points is merged, with the closest shorebird geometry point and that distance to the nearest python sighting added to the left of the Python sightings data frame.

Text, application

Description automatically generated with medium confidence

Next, I just summarize the shorebird distance to closest python, to get a sense of the new data. The output below shows that the minimum distance is 31 meters (approx. 0.02 miles), and the farthest distance is 26,641 meters (approx. 16 miles).

The plot below shows a choropleth map of the sightings relative to the distance to the nearest shorebird habitat, in meters.

Chart, scatter chart

Description automatically generated

Next, I’ve created a fishnet grid with the bounding box set to the max and min points of the python sightings. I still need to trim the bounding box to the outline/dimensions of Florida, but this should add each python sighting to a grid with polygon geometries, so I can then assess how many shorebird habitats and pythons are in each grid. I will then use the grid geometry (much in the way of census blocks) to determine spatial correlation between shire birds and python sightings.

Chart

Description automatically generated

**Next Steps**

Questions on how to run the model

* 1. What is the model to run?
* 2. How do I format the model? My first question was looking at prediction, but is it more relationship?
  + - **Linear Regression – OLS- do I look at the number of pythons sighted in each grid? Trim the grid to just the state of Florida (i.e., a mask?)**
    - **Spatial Analysis – Spatial Error or spatial Lag?**

**Do I look at distance of each sighting to the closest dependent variable – features?**

* + - **Cluster Analysis on the grid cells?–** 
      * **Merge different dataset and features into one data frame?**

Questions on what to code next

* 1. What do I do with Line Strings and Polygon vs point comparisons?
  + Do I find the centroid of the polygon?
  + Do I find the centroid of a line string? This is how the traffic data geometry is given?
    - What about pythons that are along a road, but aren’t close to its centroid? It would give it a long distance?
    - Do I put a buffer around the line string, make it a polygon and merge just on intersection?
* 2. Need to extract TIFF environmental data to the grid to get sun radiation energy and surface temperatures.

General Next Step Questions

1. Could I trim the Python data to just sightings determined by GPS/remote sensing/overhead observations? This cuts sightings down to those actively being searched/scanned by researchers, and so can help see relationship between sightings and where researchers are looking?
2. Add in all animal/water features into one dataset, with the grid polygons, along with python sightings
3. Add in the relationship to roads, and maybe urban polygon centroids as well?

**Start determining which cluster, KNN model, or regression models to run to start looking at relationships once feature engineering is completed.**

1. Willson, John D et al. “Identifying plausible scenarios for the establishment of invasive Burmese pythons (Python molurus) in Southern Florida.” Biological Invasions 13 (2010): 1493-1504. [↑](#footnote-ref-1)