Visualizing the Effect of Global Warming on Wildlife

Team 76

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I. Introduction

Impacts of global warming on wildlife and their ecosystems is evident through data collected and studies done by various government, science, and engineering agencies worldwide [13] [14]. Understanding the impact of global warming and rapid climate changes on species can play a crucial role in predicting endangerment and extinction patterns [3] [1] [16] [11]. In our project, we are studying weather data with various features such as temperatures, precipitation, wind speed, humidity etc, together with number of species being extinct and endangered with their other details. Our project analyses these two data sets and provides a data visualization tool to see how the global warming is affecting species in United States. Such a tool will be very helpful for wildlife enthusiasts, conservationists and government agencies alike to visually see the effects of global warming and take actions in treating the root cause of species endangerment/extinction and to preserve the larger ecosystem [2].

II. Problem

Here is a breakdown of the problem we are studying:

- Is the temperature really rising over time?
- Besides the effort of many government and private agencies to save species from going extinct, is the number of endangered and extinct species rising over time?
- Are the climate features such as discussed above really affecting the numbers of endangered and extinct species to go up?
- Is the impact of climate on certain outcomes independent from natural patterns through time?
- Can we visualize the impact of global warming?

III. Survey

Studying climate change and its impacts have been a popular topic among scientists since the highly cited paper about increasing atmospheric carbon and rising global temperatures was published [4]. To name a few, Frehner *et al.* proposed the Virtual Database method using advanced web-based data retrieval, analysis, and visualization [7]. Kernohan *et al.* study and analyze statistical models of animals to understand these animal movements from one place to another [8]. SOCPROG program by Whitehead *et al.* analyses animal social structures by using network statistics and a few other statistical methods and visualizes certain relationships between

social interactions and population dynamics of animal species [9]. Morik*et et al.* used data mining techniques to retrieve and analyze spatial/temporal data related to the environment for applications of sustainability to local environments and proved that spatial/temporal data are important factors for determining the likelihood of species going extinct [10]. The other study from Elmendorf *et al.* suggest using data visualization and other analytics tools to show how tundra temperature change affects the local vegetation [12]. Sheppard et al. and Neelin et al. also presented visualization to increase public awareness of climate change [15] [17]. Since the effects of animal movements are not due entirely to global warming, relationships between animal movements and global warming have not really been visualized properly in this study. There are many other studies as outlined in our progress report. We found out that all of these studies, while being important in their own respect, fall short on so many things. They do not answer the direct question we want to answer: How is global warming affecting species? Some report on just a few species and there are others which do the analysis only on specific region of US. Much of the research revolves around refining our understanding of the contributing components and psychological effects of climate change focusing on what species people care about [2] [5] [6]. This tendency to focus on a few species limits the impact of conservation efforts [18]. Our effort, a larger scale visualization of the interdependency between species, ecosystems, and climate can bridge the current limited focus on few species and required systemic view needed for impactful change. Also, most of these papers do not list specific tools used for data collection and visualization. More research is required to find related data between global warming and climate change.

IV. Proposed Method

Our approach is to look at climate data since 1980 with 6 different columns, geolocation data and endangered/extinct species to understand correlations and interdependencies between climate data and species data. It is different from what has been done not only because we are looking at all the extinct and endangered species instead of a few, we are also looking at the whole United states. We are pulling data from different sources and merging various columns to do our analysis.

A. Data Collection

Our data set comes from four sources, as listed below.

- Weather data from https://www.**weather**.gov/. API is provided for data collection purpose. The fields include year, month, state, min temperature, max temperature, severe weather conditions, and humidity.
- Red list data from https://www.iucnredlist.org/ which will have year and number of endangered and extinct species by year.
- Endangered/Extinct data from https://ecos.fws.gov/ecp/. The fields include endangered species' names, general information, image, listing status, listed date, and critical habitat.

Sample data can be found at https://github.com/qixuanHou/SpeciesCrawlingData. We wrote a web crawler in Python to collect part of the data and Selenium is also used in order to complete the data collection from this source.

- CO2 emission data is collected from https://www.eia.gov/environment/emissions/state/.

B. Data Analytics

Analysing the weather data with various columns since 1980 to see if the temperature is rising. To accomplish this, we will be using exponential double/single smoothing techniques to first remove the seasonality and find the trend. We will then employ simple regression, Random Forest and Deep Neural Network regression techniques to prove that the temperature is really rising. We will also see the relationship between the multivariate models over time with VAR analyzing over time the relationship between animal population outcomes and climate.

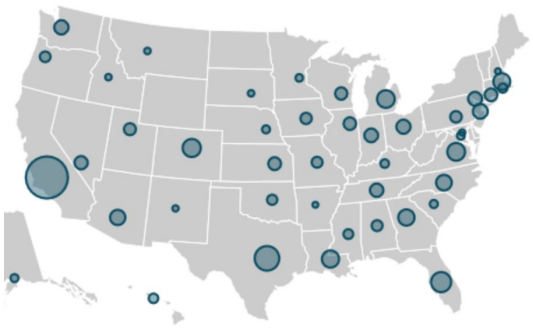
We will also analyse endangered/extinct data set to see the trend in the total number of such species over time. For this purpose, we will be using modified regression and curve fitting techniques from machine learning.

Our third approach is to combine weather data with 6 columns and endangered/extinct data with 2 columns. Together with the approaches above, we will be looking at support vector machine and logistic regression in classifying whether a certain species falls in extinct or endangered class.

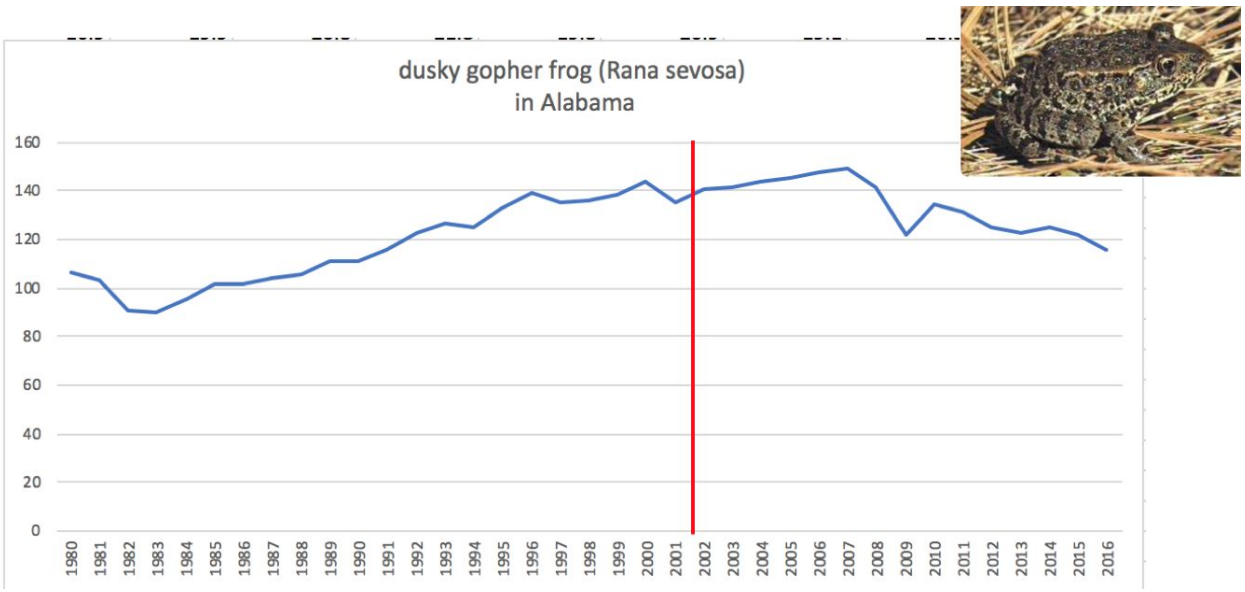
C. Data Visualization

Our fourth and final approach will be to record all the above analysis in a visualization with a statewise geolocation data to find out which parts of the US is hit hard by the problem of extinction/endangerment. We will also be including other details about the species in this interactive visualization tool. The visualizations to convey results of data analysis results will be added later. The following descriptions show our current design for a user interactive visualization.

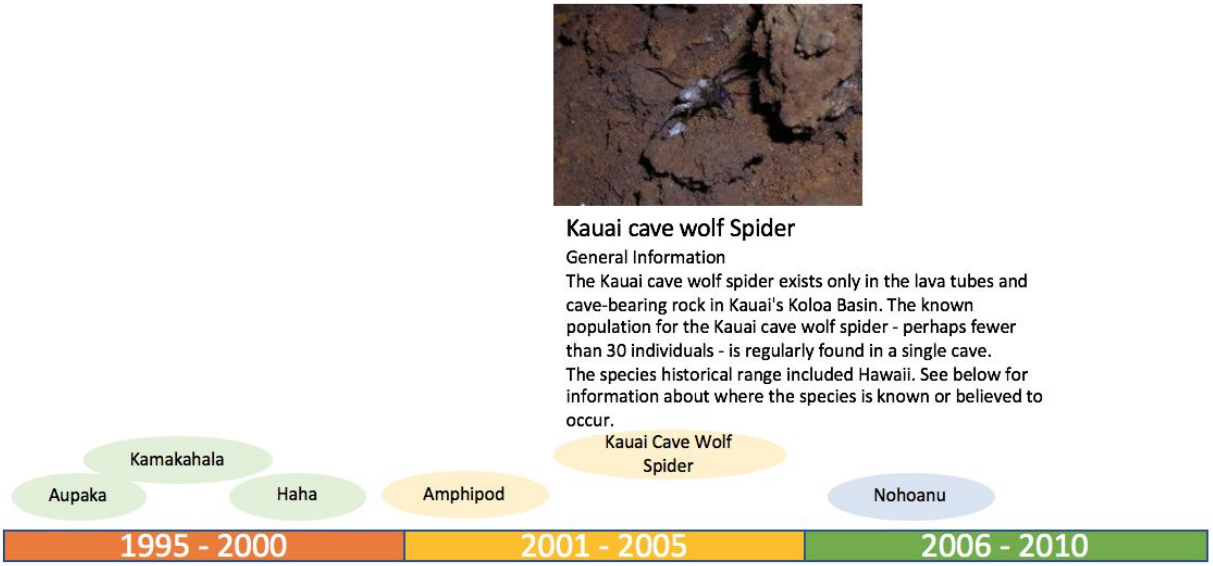
Since not everyone has in-depth knowledge about endangered species, we provide a gridview with endangered animals/plants' images, names, and general information. User can click on each animal to navigate into the detailed analysis.



There are three major types of visualizations. The US map displays the geolocation information of endangered species. The dots indicate the occurrence of certain animal in the corresponding state. We can also use different colors to represent different species in one map. If user clicks on one dot, the weather and CO2 emission data of the location should be displayed below.



The second type of visualization is line chart to demonstrate time series information. The example above shows CO2 emission data in Alabama from 1980 to 2016. The red line marked December 2001 as the month when rana sevosa was listed as endangered by U.S. fish & wildlife service. More lines can be added to the graph above to demonstrate temperature change, humidity change. Severe weather conditions can also be marked above.



The last type of visualization is a timeline, majorly for users to explore the history. The figure above shows a sample of timeline, including endangered species information in Hawaii. The bubble indicate the time when the animal/plant is listed as endangered or threatened. If user

clicks on one animal, such as Kauai Cave Wolf Spider, the user can view detailed information and the image if available. The data analysis results will also be included in the detail.

Tools we will use in the projects are: Python with it's various packages like scikit learn, Kera ; R; JavaScript; D3 and other visualization tools.

V. Experiment & Evaluation

We will divide and use test and train data to come up with the model and test the models. We plan to use K-fold cross validation and leave one out cross validation techniques to make sure that our result are unbiased and follow our intuition.

Under construction

VI. Conclusion & Discussion

Under construction

VII. Plan of Actions

Each team member is actively involved in the work, attending our virtual meeting, giving each other feedback and editing our reports.

A. Old Plan

Week 1 (March 3 - March 10)(Qixuan, Karthik, Archit)

- Collect weather data
- Write script for web crawling endangered species data

Week 2 (March 11 - March 18) (Karthik, Prashant, Archit)

- Data cleansing
- Explore and design visualizations

Week 3 (March 19 - March 26)(Justin, Qixuan, Man)

- Use various data analysis such as regression, time series and other machine learning techniques.

Week 4 (March 27 - April 3) (Everyone will contribute)

- Design and build interactive visualizations, graphs of the result.

Week 5 (April 4 - April 11)(Man, Justin, Prashant)

- Write the report
- Design the poster
- Work on slides for the project

Week 6 (April 12 - April 19)(Everyone will contribute)

- Work on project presentation videos individually

B. Activities of each group member & Current Plan

Week 1 (March 3 - March 10)
- Collect weather data (Archit)
- Write script for web crawling endangered species data (Karthik, Qixuan)

Week 2 (March 11 - March 18)
- Data cleansing (Karthik, Archit)
- Explore and design visualizations (Qixuan)
- Explore machine learning options (Mann, Justin)

Week 3 (March 19 - March 26)
- Prepare progress report (Mann, Qixuan)
- Explore and design visualizations (Qixuan)
- Explore machine learning options (Mann, Justin)
- Data preparation (Karthik, Archit)

Week 4 (March 27 - April 3) (Everyone will contribute)
- Conduct data analytics
- Design and build interactive visualizations, graphs of the result

Week 5 (April 4 - April 11) (Everyone will contribute)
- Write the report
- Design the poster
- Work on slides for the project

Week 6 (April 12 - April 19)(Everyone will contribute)
- Work on project presentation videos individually

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