Visualization for Data Science

Project Extinct Animal Tracker

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Repository Link

https://github.com/dataviscourse2024/group-project-extinct-animal-tracker

Website link

https://dataviscourse2024.github.io/group-project-extinct-animal-tracker/

Background and motivation

"Be kind to animals, great and small, for they deserve our care, one and all." This profound statement underscores the importance of compassion toward the creatures with whom we share this planet. Animals play an essential role in maintaining the balance of ecosystems, yet they are disappearing at an alarming rate. Our visualization project, "Endangered Species," seeks to explore pressing questions: Is humanity responsible for the decline of these species? How are they being endangered? Most importantly, what actions can we take to ensure their survival?

The purpose of this initiative is not just to inform but to inspire action. By leveraging interactive data visualizations, we aim to raise public awareness about the plight of endangered animals and shed light on the complex causes threatening their existence, including habitat destruction, climate change, and pollution. These threats, often a direct result of human activity, are pushing many species to the brink of extinction, with profound consequences for our planet's delicate ecological balance.

Why does it matter? The loss of animal species disrupts food chains, destabilizes ecosystems, and can have far-reaching effects on human life, including the availability of resources and the health of our environment. According to the International Union for Conservation of Nature (IUCN) Red List, over 41,000 species are currently at risk of extinction, and this number continues to grow at an alarming pace. Every extinction represents a loss of biodiversity, cultural heritage, and scientific potential.

Our project strives to make these issues tangible and relatable by presenting compelling data stories through a range of visual elements. By highlighting the severity of the problem and illustrating how human actions have contributed to it, we hope to foster empathy and drive conversations about conservation efforts. Additionally, the project emphasizes actionable steps individuals and communities can take to contribute to the preservation of endangered species, such as supporting sustainable practices, reducing pollution, and advocating for stricter wildlife protection laws.

Through "Endangered Species," we aspire to move beyond merely presenting facts. We seek to create an emotional connection, inspiring a sense of responsibility and collective effort to protect the incredible diversity of life on Earth. Every species, no matter how great or small, has a role in maintaining the health of our planet. Let us act before it is too late to ensure that future generations inherit a world rich in wildlife and wonder.

Domain Goals and Target Audience

The primary goal of this project is to create an interactive, web-based tool that provides detailed insights into the conservation status of endangered species worldwide. This tool offers users access to comprehensive information about where endangered species are located, how their populations have declined over time, and the current state of biodiversity globally. Using data from credible sources like the IUCN Red List, the project aims to present a clear and engaging overview of the critical state of the world's wildlife.

Key Features and Questions Addressed:

1. Species at Risk: Which species are currently at the highest risk of extinction?
2. Population Trends: How have the numbers of threatened species changed over time?
3. Geographic Distribution: Which regions of the world are experiencing the greatest decline in species, and how do these trends vary by location?

Purpose and Vision:
This visualization is not about solving the problem but about raising awareness by providing accurate, accessible information. By visualizing patterns in species decline and showcasing regional and global trends, the tool aims to:

- Help users better understand the current state of endangered species across the globe.
- Highlight critical regions where biodiversity is most at risk.
- Offer a compelling visual representation of how rapidly species populations are declining.

The project is designed for a general audience, ensuring that anyone who interacts with the tool can grasp the severity of the situation. The visualization serves as a powerful reminder of the importance of preserving biodiversity and the urgency of understanding the threats to Earth's wildlife before it's too late.

Data Collection Process

Our project began with an in-depth analysis of potential data sources for tracking extinct and threatened species. After thorough research, we identified two primary resources:

1. IUCN (International Union for Conservation of Nature), which maintains the widely recognized "Red List" of threatened species.

2. GBIF (Global Biodiversity Information Facility), another valuable data repository, which we planed to explore for future visualizations

Accessing Data via IUCN API V

Once we finalized IUCN as our data source, we explored the IUCN API V4. This API provides access to a vast array of taxonomic data and assessments of species, which inspired us to create visualizations focusing on global extinction patterns. One visualization idea was a heatmap displaying the countries with the highest number of species facing extinction

Data Processing Challenges

During the data exploration phase, we faced a few hurdles:

1. The IUCN API did not offer a single endpoint that provided a direct list of threatened species by country. Instead, it returned multiple assessments requiring extensive processing.

2. We shifted focus from the API and started exploring spatial datasets that matched our map-based visualization needs. This led us to .shp (Shapefile) formats, which contained the geospatial data we required.

Data Conversion Using QGIS

To integrate the spatial data into our visualizations, we used QGIS (a free GIS software) to convert the shapefiles into GeoJSON format, which is compatible with mapping libraries. However, when feeding the GeoJSON data into Chart.js, we encountered numerous errors. These issues made us reconsider our data approach.

Obtaining Country-Level Data from IUCN

In search of a more efficient method, we directly contacted IUCN to request the data. They provided us with a CSV file containing country-wise data for threatened species. This file became the foundation for our current map visualization

Data Transformation and Mapping

To process the country-wise data:

1. We converted the CSV file into JSON format, making it easier to manipulate within our app.
2. Chart.js required ISO 3166 country codes for accurate mapping of the species data. However, our dataset lacked these codes. To resolve this, we downloaded a separate JSON file of country codes and matched it to our species data.

3. Using a hash map, we linked the country codes to the respective number of threatened species

Second dataset
Later in the process, we acquired a dataset detailing species extinction rates by country, covering the years 2020 to 2024. This data provided valuable insights into how nations are progressing toward biodiversity conservation as part of the United Nations Sustainable Development Goals (SDGs). Leveraging this information, we were able to create more refined and impactful visualizations, offering a clearer picture of the global conservation landscape and trends.

At the end we concluded there 2 data sources.

1. **IUCN Red List: Summary Statistics (Table 5)**
    - This data source provides a comprehensive list of threatened species per country globally, categorized by their risk levels. It includes the distribution of species under various categories such as Critically Endangered, Endangered, and Vulnerable, offering insights into biodiversity threats across different regions.
2. **United Nations SDG Goal 15.5.1: Red List Index Data**
    - This dataset focuses on the species extinction rate per country, with detailed data spanning the years 2020 to 2024. It supports an in-depth analysis of how countries are progressing toward biodiversity conservation goals as part of the United Nations Sustainable Development Goals (SDGs).
    - **Metadata Link**

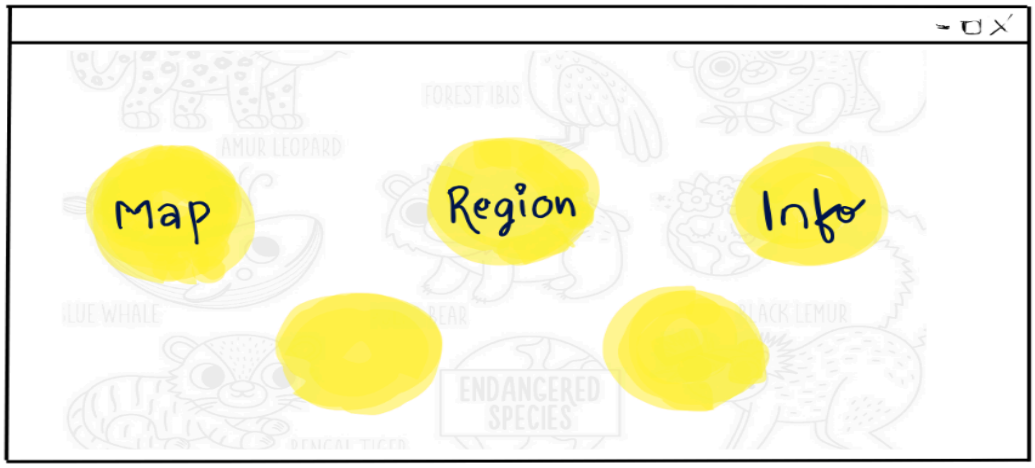
By integrating these datasets, we aim to build a robust analysis of biodiversity trends, conservation efforts, and global challenges to species survival.

Initial Draft

In the first week of the project, our primary focus was on brainstorming and experimenting with various visualization techniques to effectively present data on endangered species. We conducted thorough research on existing visualization methods to identify approaches that best communicate:

- Patterns in species decline.
- Regional biodiversity loss.
- Global trends in conservation and extinction risks.

Our efforts included evaluating tools such as D3.js, Chart.js, and other visualization libraries for their ability to handle complex datasets. We also explored design principles to ensure clarity, interactivity, and aesthetic appeal in our visualizations. These experiments laid the groundwork for selecting the most effective techniques to represent the data meaningfully while engaging the audience.



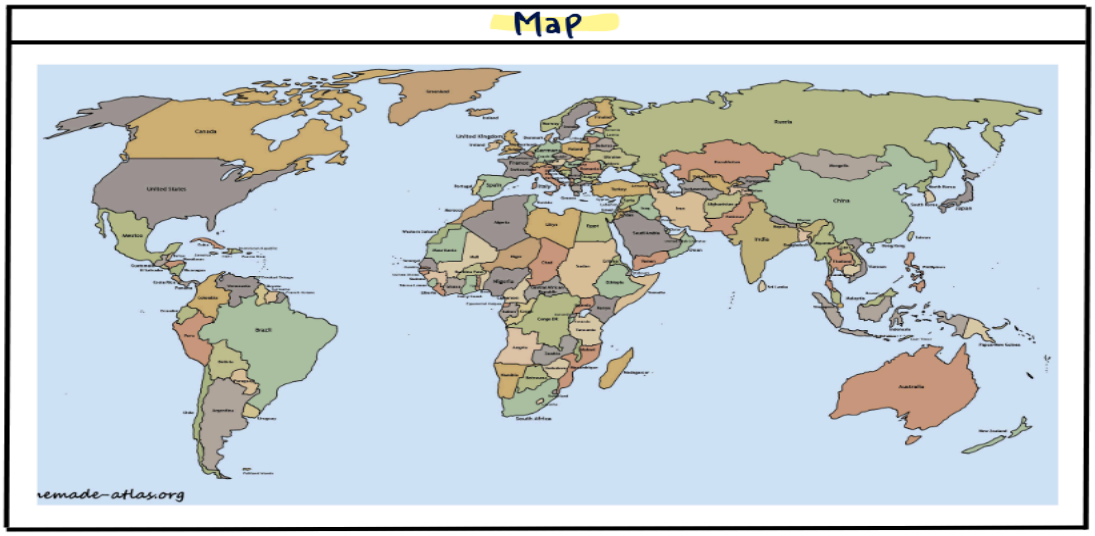
Before our meeting with the teaching assistant, we developed initial design concepts for the web application to visualize endangered species data. The core idea centered around creating an intuitive and visually engaging interface.

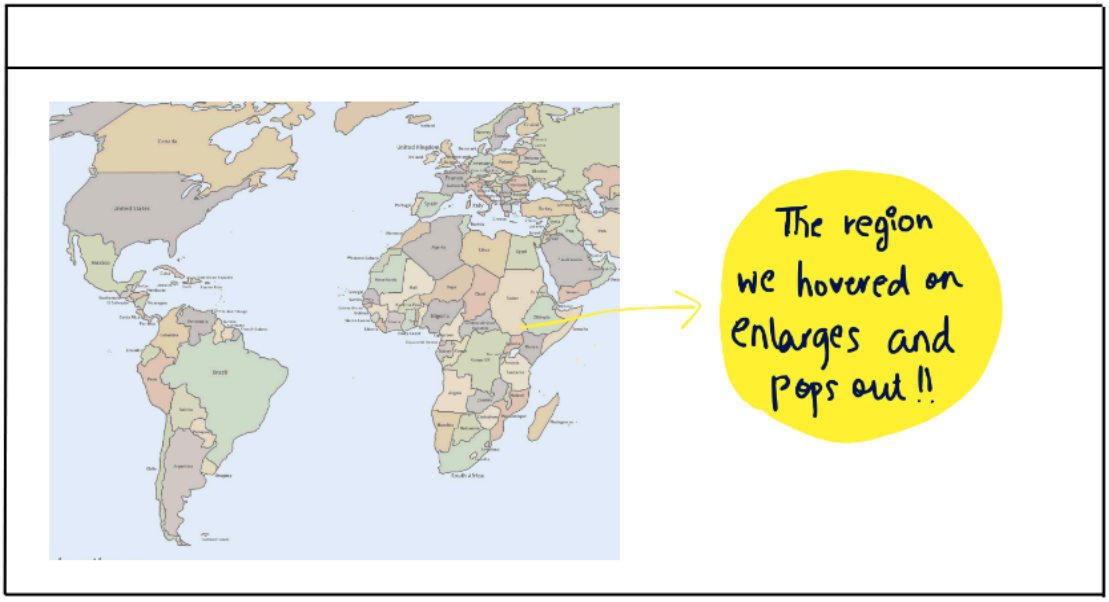
Our initial concept featured:

- **Navigation Buttons:** Three primary buttons labeled **Map, Region, and Info** are arranged within a **yellow circular layout**, providing users with a simple and straightforward navigation experience.

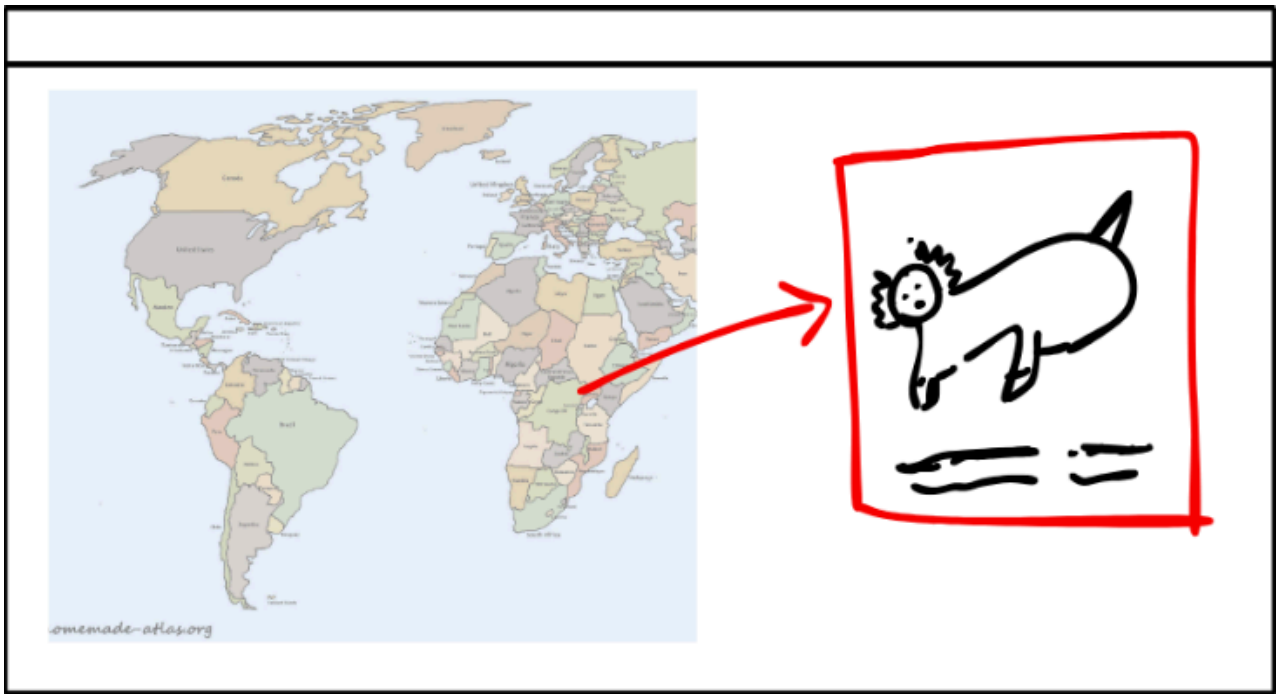
- **Background Design:** A subtle background with faint **sketches of animals** paired with the title **Endangered Species** to emphasize the theme of wildlife conservation and geographic data visualization.

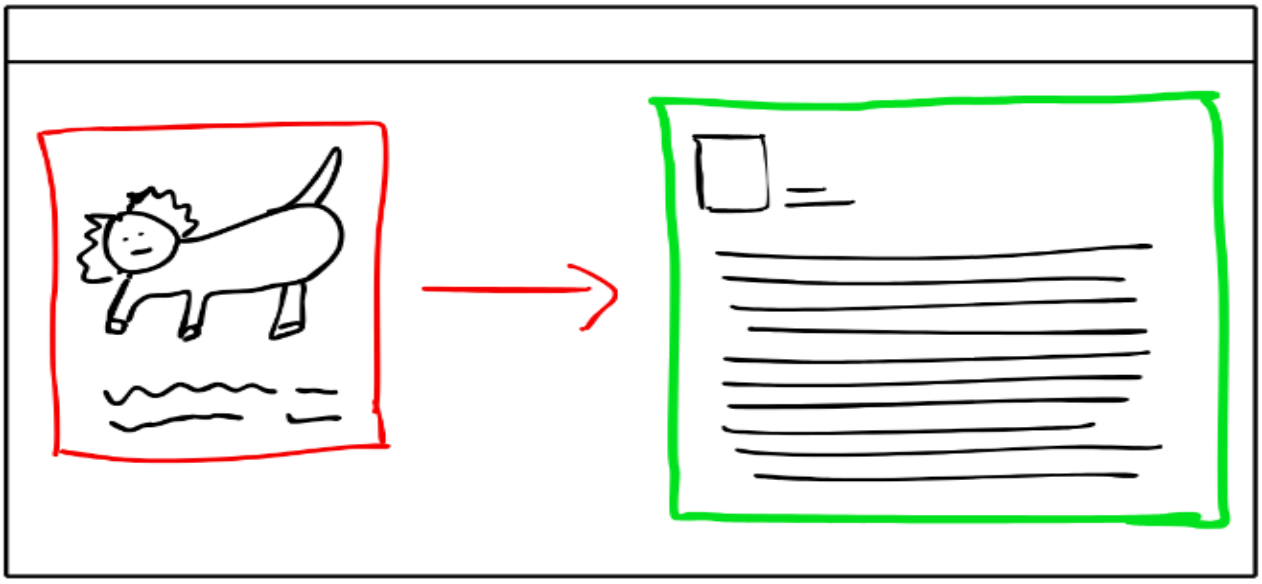
This rough sketch served as a starting point, enabling us to visualize the core functionality and aesthetic of the application. During our meeting with the teaching assistant, we discussed these ideas and received valuable feedback, which guided subsequent refinements and adjustments to the design.





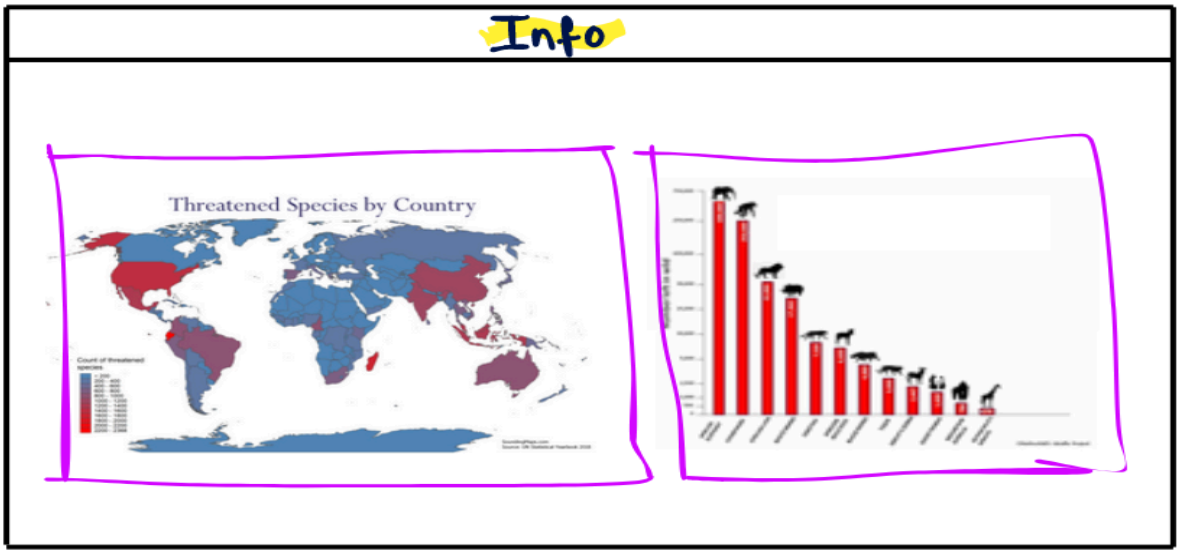
The initial sketches above depict that clicking on the ‘Map’ button displays an interactive world map. When the cursor hovers over a specific region, that area enlarges and pops out, creating a dynamic and engaging visualization. This feature was designed to enhance user interaction and provide a more intuitive way to explore geographic data related to endangered species.

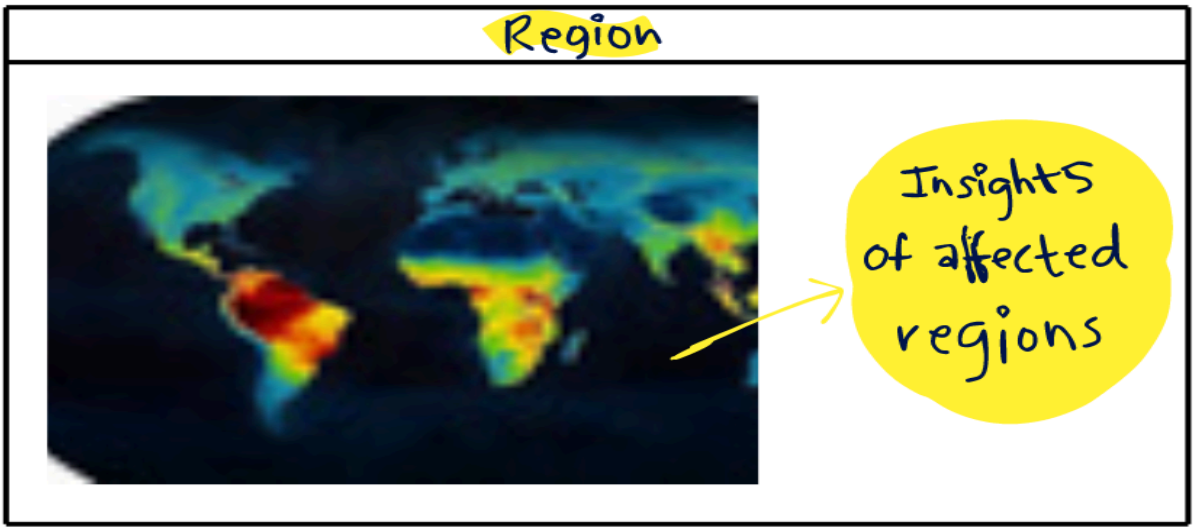




In the images above, the design illustrates an animal card that appears when hovering over a specific region on the map. The card provides basic details about an extinct or endangered animal associated with that region. For users who wish to learn more, clicking on the card

reveals additional information, offering a deeper exploration of the species and its conservation status. This feature aims to make the application both informative and user-friendly.





These images above showcase infographics highlighting regions with the highest extinction cases. We plan to visualize this data using a heat map, where regions with darker or redder colors indicate areas with the most extinctions, while lighter colors represent regions with fewer extinction cases. Additionally, we are considering incorporating a bar graph to depict the time-series pattern of extinctions over the years, providing insights into trends and changes in extinction rates over time. This combination of visualizations aims to present the data in a clear and impactful manner.

Must-Have Features

These essential features are critical to the project's success:

1. Interactive Map:
    - A map that displays species statuses geographically.
    - Includes filtering options for users to refine data by species type, threat levels, or regions.
2. Species Population Timeline:
    - A time-series visualization that shows how species populations have evolved over the years.
    - Offers insights into trends and patterns.
3. Basic Information on Species:
    - Clicking on a species provides key details, such as habitat, primary threats, and conservation efforts.
4. Heat Map:
    - A visualization that uses color intensity to indicate extinction severity.
    - Darker colors represent regions with higher extinction cases, while lighter colors represent less-affected areas.

These features, while not critical, would enhance user experience and engagement:

1. User-Generated Insights:
    - Allows users to contribute observations, comments, or personal insights about specific species or regions.
2. Mobile Optimization:
    - Ensures the application is fully functional and visually appealing on mobile devices.
3. Data Export:
    - Allows users to download datasets in various formats for offline analysis or integration into other tools.

This prioritization ensures the core functionalities meet user needs while leaving room for future enhancements.

First meet with the TA (Rifat Ara Proma)

During our first meeting with the teaching assistant, we presented our initial project idea. While they appreciated our effort, they pointed out that the concept was too basic and lacked the depth required to stand out. The TA emphasized that merely presenting information would not be sufficient to capture the audience's attention or provide a meaningful experience.

They encouraged us to incorporate more advanced visualizations and interactive features to elevate the project. The focus, they explained, should be on engaging users actively, making them want to explore and interact with the data rather than passively consuming it. Suggestions included dynamic elements such as animations, clickable components, or layered visuals that could tell a compelling story.

The TA also stressed the importance of making the visuals not only functional but also striking and memorable. By designing unique and immersive features, the project could leave a lasting impression on users.

This valuable feedback inspired us to rethink and broaden our approach. We are now prioritizing the creation of an engaging user experience by integrating interactive maps, data-driven visualizations, and exploratory elements. Our goal is to transform the project into a tool that not only informs but also excites and inspires users, making a meaningful impact.

Map Visualization

In week two, we began working on the project by focusing on the map visualization. However, we encountered several challenges—the map was not rendering well and failed to display data accurately. Issues with region handling and interactions further complicated progress. Simultaneously, we worked on cleaning the dataset to ensure its accuracy and suitability for the visualizations. This step was critical, as the quality of the data directly influences the reliability and relevance of the visualizations. Despite the setbacks with the map, we prioritized troubleshooting the issues while continuing to refine the data in parallel. This phase allowed us to identify gaps in our approach and make necessary adjustments to our plans.

This was our initial concept for a heat map.

In week two, we made significant progress on the project. We began by designing and building the front page using ReactJS with HTML, CSS and JS. This process involved structuring the overall layout, carefully styling the elements, and ensuring that the design was both visually appealing and user-friendly. Our primary goal was to create a clean, functional interface that would effectively showcase the project's purpose while providing a seamless experience for users. We also focused on making the page intuitive and responsive, laying a strong foundation for future components and interactions.

Simultaneously, we delved into data visualization by exploring D3.js and Chart.js, two robust JavaScript libraries. Learning D3.js proved to be a steep learning curve, as it requires an understanding of binding data to DOM elements, managing scales, axes, and creating dynamic, interactive visualizations. However, the flexibility and power of D3.js made it worthwhile,

allowing us to experiment with unique ways to represent our data. On the other hand, Chart.js provided a simpler and more straightforward approach, which was helpful for creating basic charts and quick prototypes. Experimenting with these tools expanded our understanding of visualization techniques and provided us with a variety of options to present data effectively.

As we made progress, challenges began to emerge. One of the key hurdles was integrating the cleaned data into the visual elements. This required not only understanding the data structures but also aligning them with the visualization logic, which occasionally led to unexpected results or errors. Debugging these issues became an iterative process, involving adjustments to both the data formatting and the visualization code.

Despite these challenges, by the end of the week, we had a solid foundation for both the project's design and the data visualization aspects. The front page was functional and aligned with our initial goals, and we had gained enough familiarity with D3.js and Chart.js to move forward confidently. This progress set the stage for tackling more complex visualizations and interactions in the weeks ahead, as we continued refining our approach and building on what we had learned.

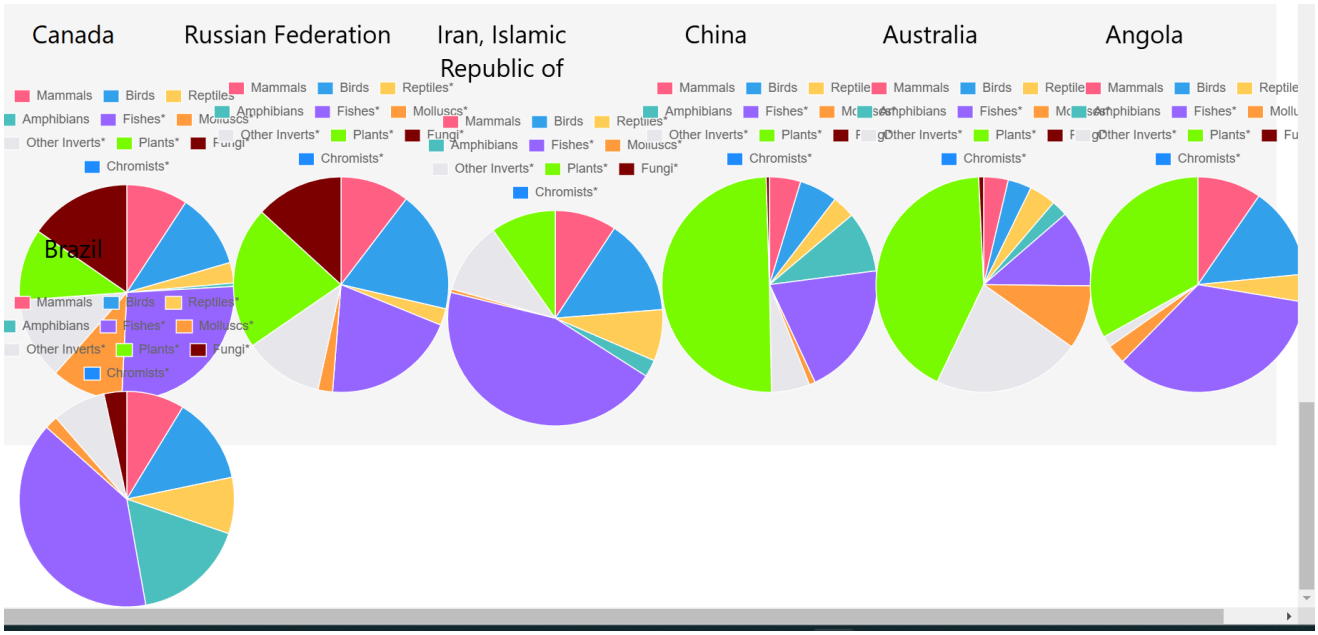
Line chart and pie chart

In week three, we focused a lot on creating the line chart and pie charts for our project, but both came with their own set of challenges.

The line chart, which was meant to represent the changes in species populations over time, initially caused a lot of issues. We faced problems with the accuracy of the data representation. The data points weren't aligned correctly, and the line connecting them didn't properly reflect the trends we wanted to display. The axis scaling was also problematic—values didn't match up with the data points, causing the chart to look misleading. Additionally, the scrolling feature that we wanted to implement wasn't functioning properly. As users tried to scroll through the data, the chart became unresponsive or displayed distorted results. We realized that the scaling of the axis and how the data was rendered needed significant adjustments. This meant we spent a lot of time troubleshooting and refining the code to ensure the line chart worked smoothly and displayed the information correctly.

At the same time, we worked on the pie charts, but they also had some issues. When we tried to display multiple pie charts on the page, they began to overlap with each other. This made the page look cluttered and made it difficult for users to interpret the charts. The overlapping issue persisted even after we tried adjusting the layout and positioning. We had to experiment with different options to fix this, but it was clear that we needed a more refined approach to ensure the pie charts were displayed clearly and without any overlap.

By the end of the week, while we had made some progress with the bar chart, the line and pie charts still needed more work. The line chart required further adjustments to fix the axis scaling and scrolling issues, while the pie charts needed a better layout to prevent overlap. These issues were our main focus, and we planned to continue working on them in the following weeks. Please refer to the images below.


Canada
Russian Federation
Iran, Islamic Republic of
China
Australia
Angola
Brazil
Mammals
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Fishes*
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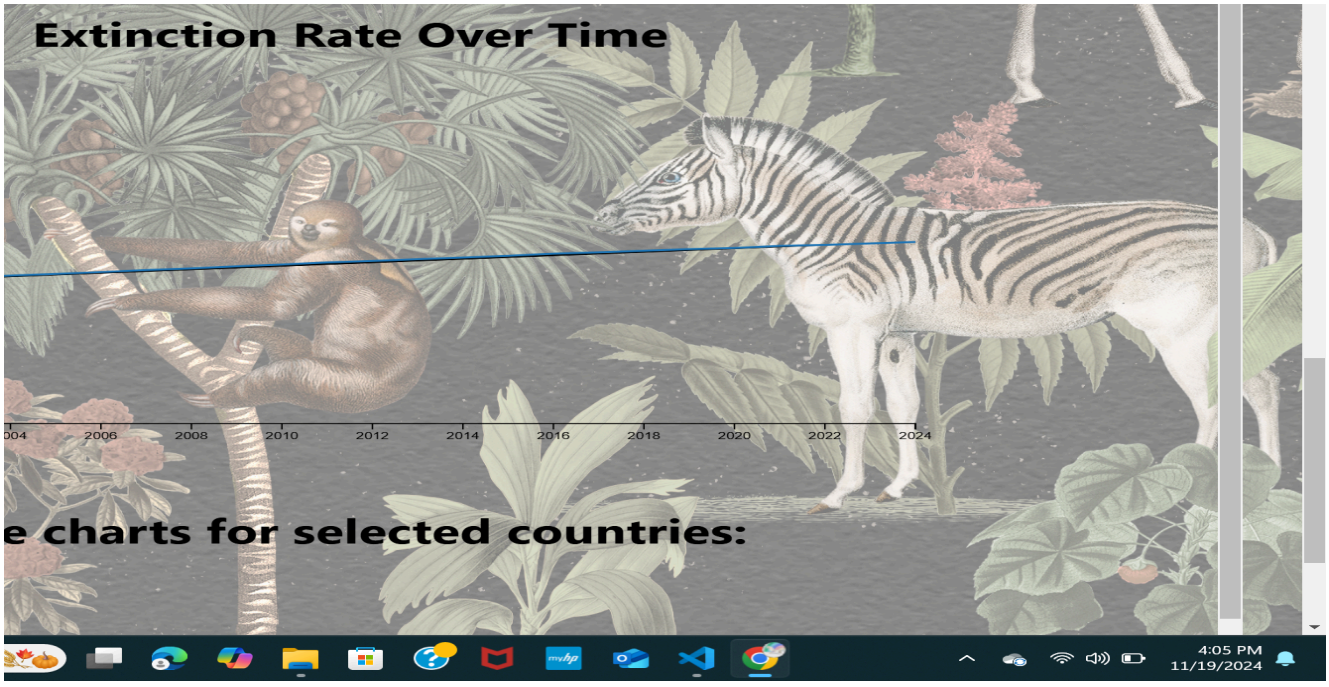
Other Inverts*
Plants*
Fungi*
Chromists*


Extinction Rate Over Time
2004
2006
2008
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2014
2016
2018
2020
2022
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e charts for selected countries:
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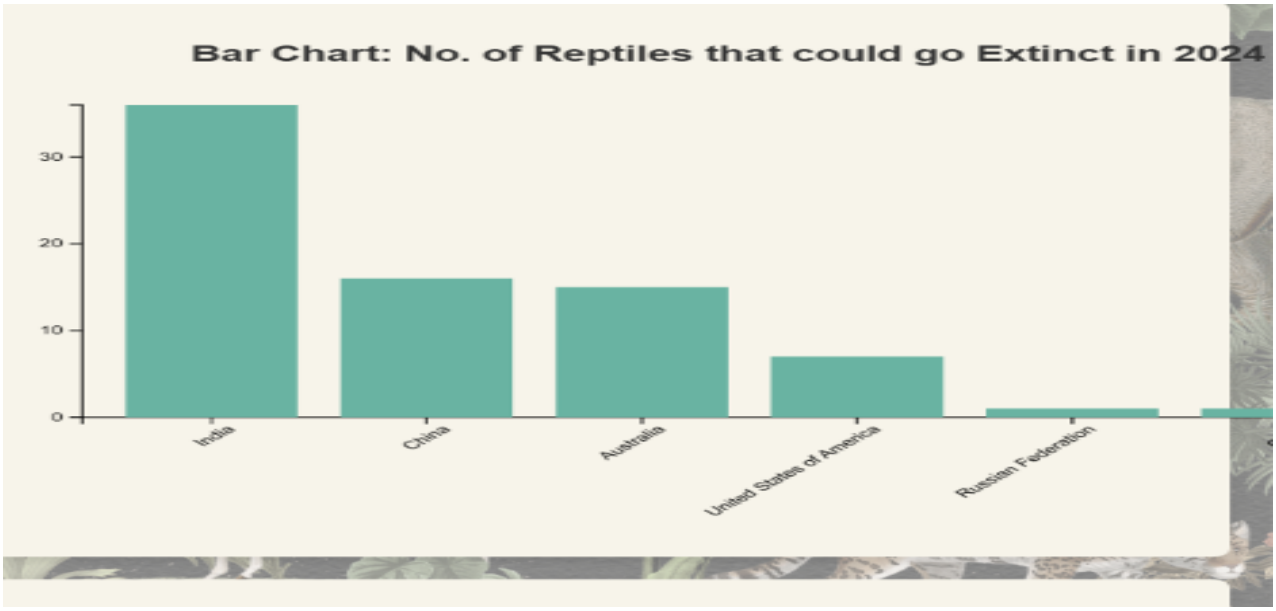
Bar chart

We created a bar chart to predict the number of species that could go extinct in 2024 for selected countries, which added an important predictive layer to our project. However, the bar chart didn't turn out as perfectly as we had hoped, and it didn't fully meet our expectations.

While the idea behind the bar chart was to provide a clear comparison of extinction risks across different countries, the final result still had several issues. The chart did not display the predicted extinction numbers as accurately or clearly as we wanted. There were some alignment problems with the bars, which made it harder for users to easily interpret the data. The chart also didn't scale well, especially when comparing countries with significantly different extinction predictions. As a result, some bars appeared too small or too large, leading to a less effective visualization.

Additionally, the bar chart didn’t integrate smoothly with the rest of the visualizations. We wanted the bar chart to complement the map, line chart, and pie charts by offering a simple yet impactful comparison of predicted extinction risks. However, the design still needed more refinement to make the data presentation clearer and more intuitive. We were also not satisfied with the way the information was displayed in relation to other elements on the page, as it didn’t flow as cohesively as we had intended.

Despite these challenges, we recognized the value of having a bar chart for predictive data. We were determined to fix the issues and improve its accuracy and design in the coming weeks. The bar chart was still an important part of our project, offering a forward-looking view of potential extinction risks, but it required further adjustments to reach the level of quality we had envisioned.



Adding extra features

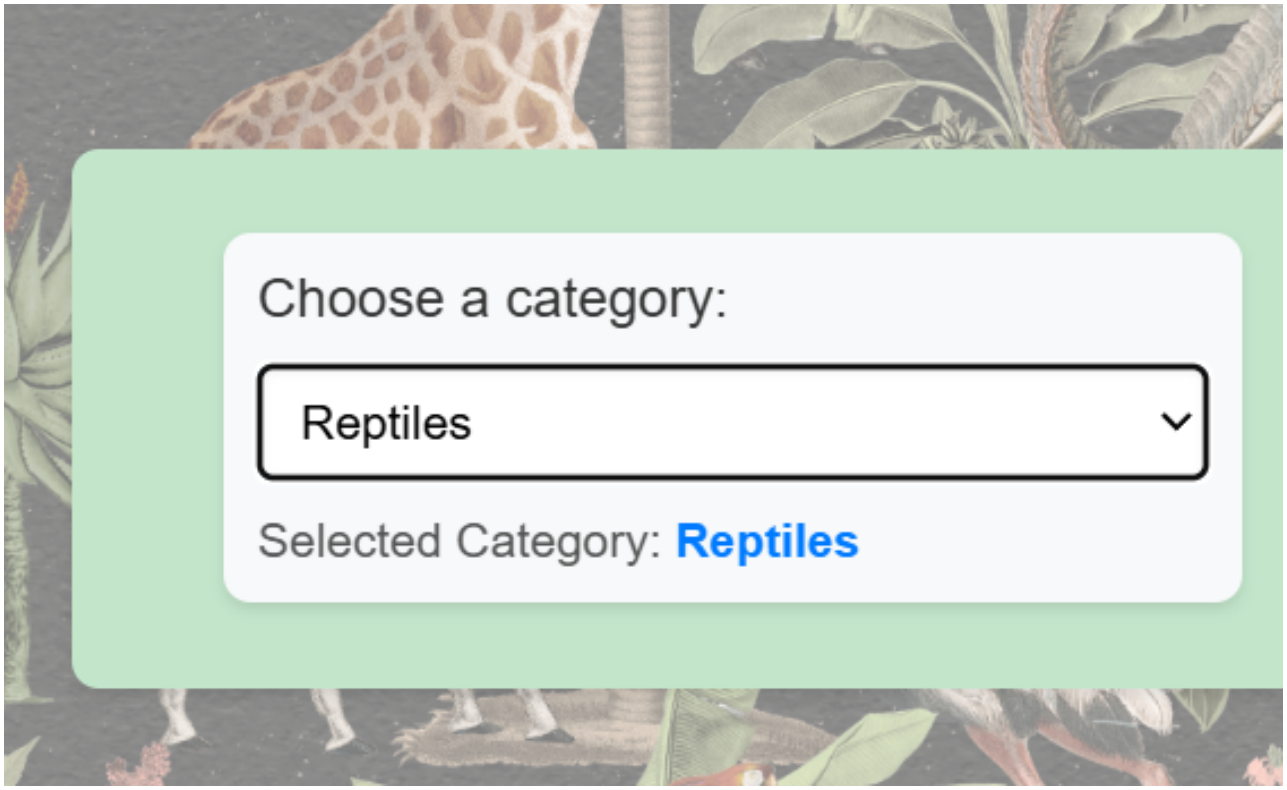
The next week, we focused on refining the bar chart to improve its accuracy and overall design. After addressing the previous issues, we were able to make significant improvements. We fixed the alignment problems, ensured the bars displayed the correct data in a clear and consistent way, and adjusted the scaling so that the comparisons between countries were more visually accurate. After several iterations, we reached the final version of the bar chart that met our expectations and provided users with a better, more reliable view of the extinction risks in 2024.

In addition to refining the bar chart, we also added some extra features that were part of our earlier goals to enhance the user experience. One of the key features we added was a drop-down box. With this feature, users could select a specific species, and the visualizations would automatically update to display only data related to that selected species. This allowed users to focus on one species at a time and gain a more personalized and detailed view of the extinction risks for that species across different countries.

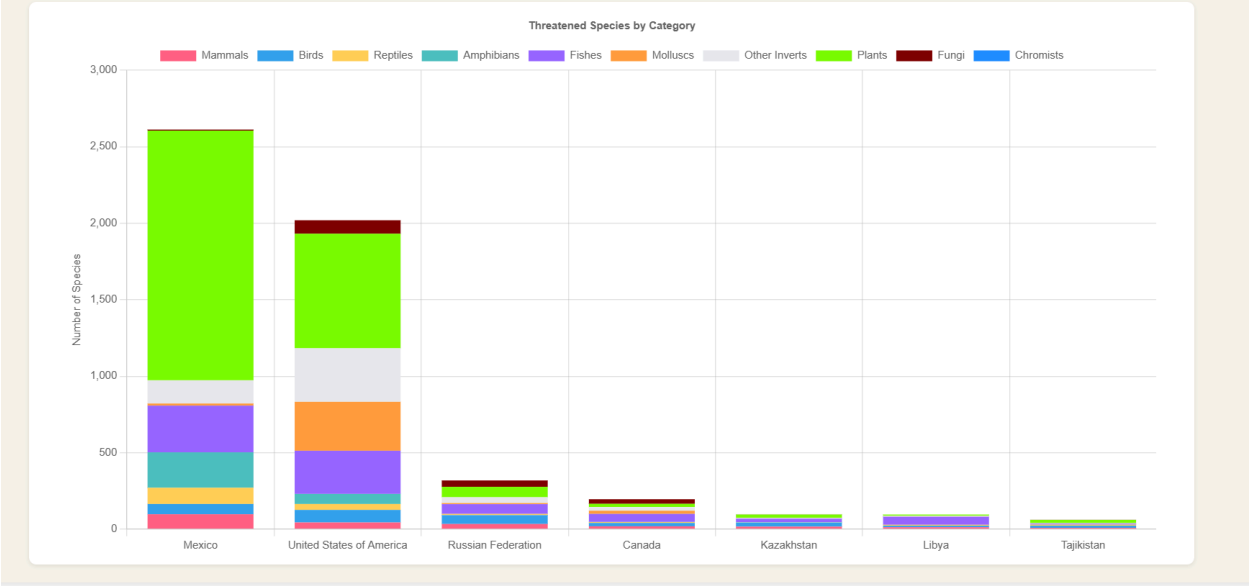
Furthermore, we introduced a category definition box. When users selected a species, the box would display a clear definition of that species, helping users understand the specific characteristics of the species they were viewing. This feature was designed to improve the accessibility of the project, ensuring that users with varying levels of knowledge about species could easily grasp the context and significance of the data being presented.

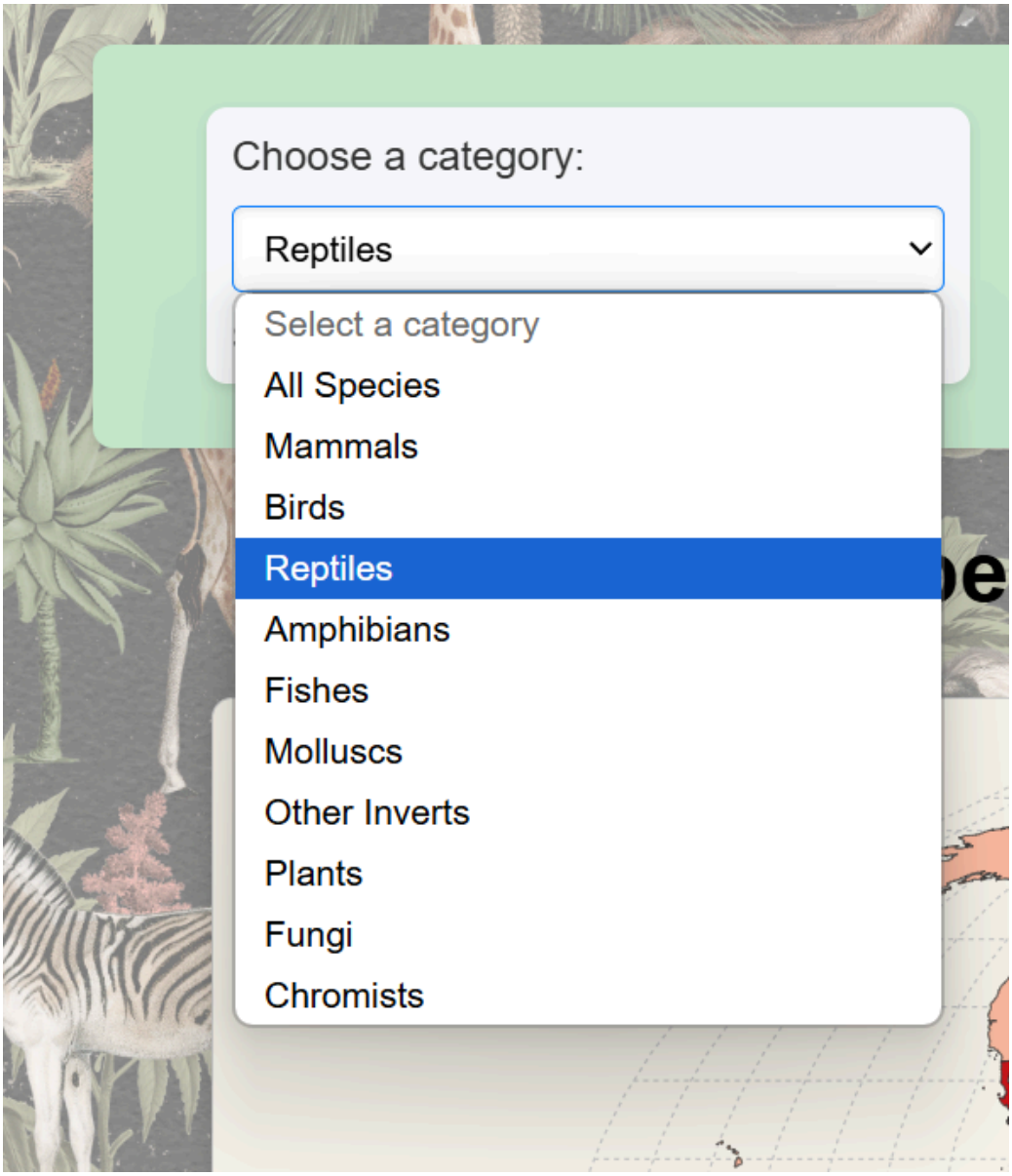
Moving forward, we also developed a stacked bar chart to complement the data presented in the pie chart. This visualization displayed the different categories of species affected within a specific country, offering a more detailed breakdown of the impact. By placing this chart below the pie chart, we created a cohesive flow of information that allowed users to explore high-level data through the pie chart and then dive deeper into the specifics with the bar chart.

These enhancements, along with the refined bar chart, made the visualizations more interactive and informative, allowing users to explore the data in a more meaningful way. With the drop-down box and category definition box, we were able to provide a more user-friendly experience, ensuring that users could easily navigate the content and better understand the information being presented.



Stacked Bar chart



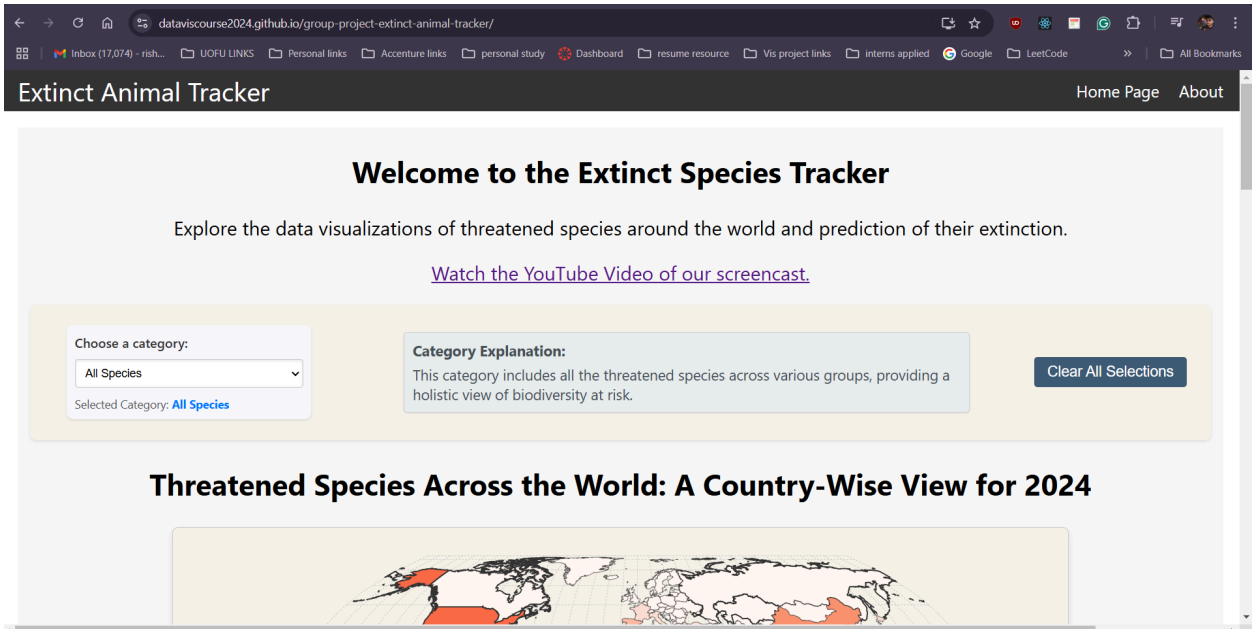


Category Explanation:
Reptiles are cold-blooded vertebrates with scaly skin, typically laying eggs. Examples include crocodiles, turtles, and lizards.

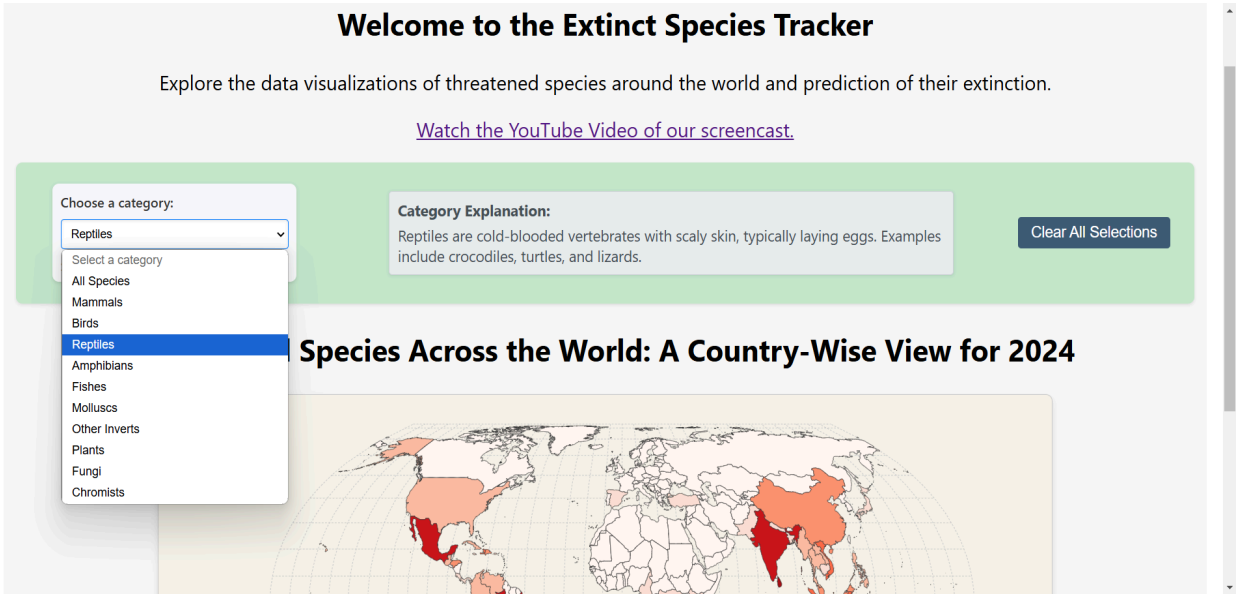
Clear All Selections

Final Vision:

1)The first image of the project is the homepage of our *Extinct Animal Tracker* website. The homepage serves as the user's entry point into the interactive experience. Here, visitors can see the *About Us* section, which briefly introduces the purpose and goals of our project. A dropdown box is also featured, allowing users to select a specific category (e.g., Mammals, Birds, Marine Life, etc.). Upon selecting a category, a short definition or description of the chosen category is displayed, giving users context on what they are about to explore. The homepage is designed to be simple and user-friendly, offering easy navigation to the site's various sections.



2)Once a category is selected from the dropdown menu, the site presents an interactive world map. The map visualizes the extinction rates of species based on the selected category. Hovering over each country reveals the number of species at risk of extinction within that region. This feature makes it clear how widespread the extinction crisis is, offering users the ability to visually explore global data at their own pace. Each country on the map is color-coded based on the extinction rate of species, making it easy to identify high-risk areas at a glance.



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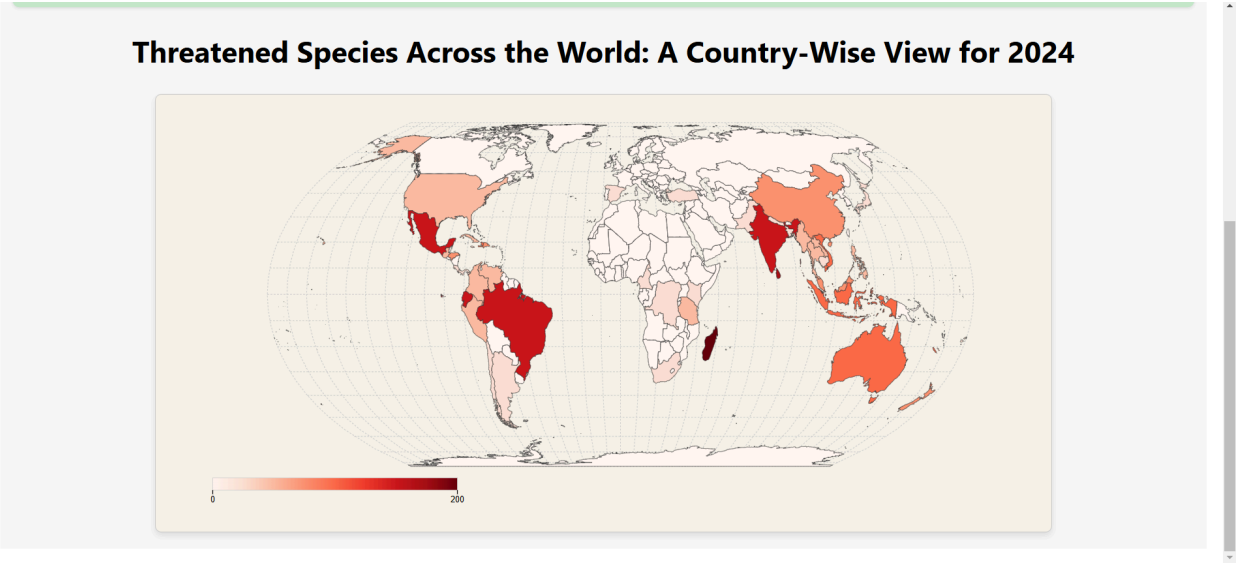
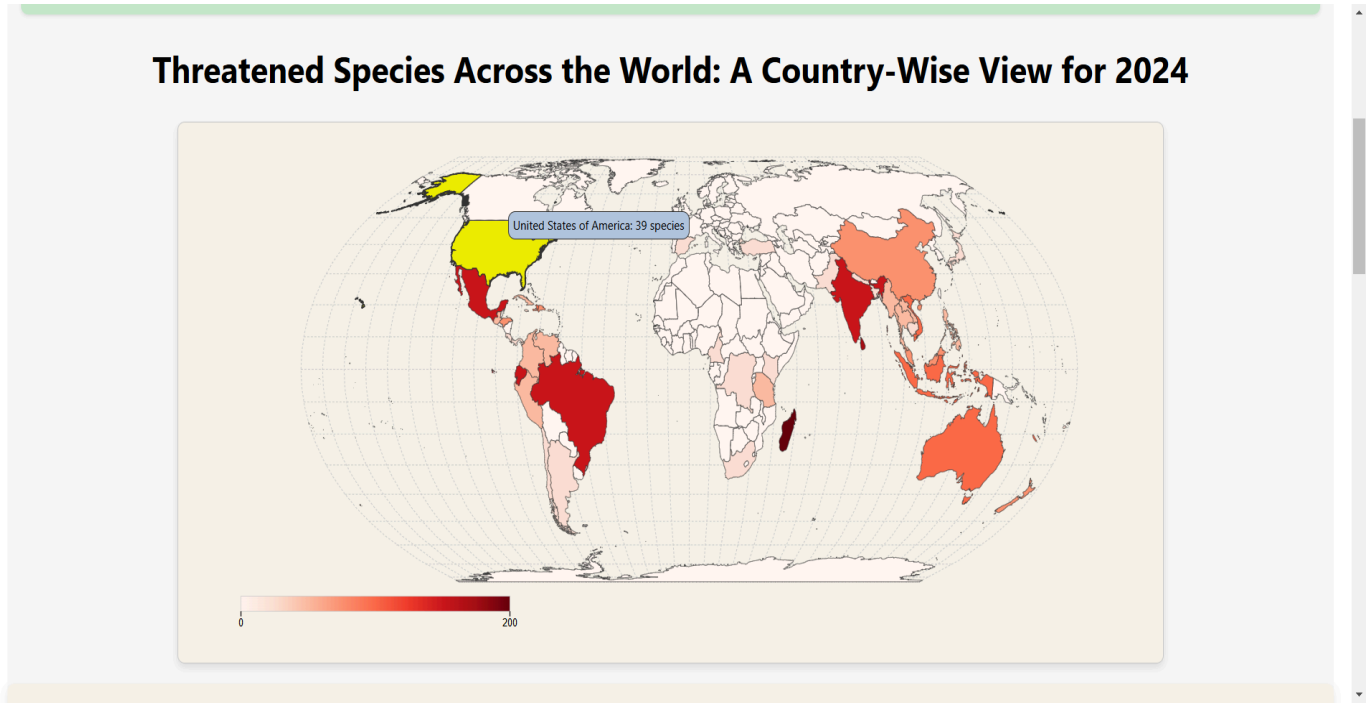


In this section of the website, users can click on specific countries to dive deeper into the data for that region. After selecting a country, the visualization updates to show detailed statistics for that country's threatened species. This feature allows users to see a more granular view of how species are affected within specific countries, offering a localized perspective on global biodiversity loss. The interactivity ensures users can zoom into countries of interest and better understand how local ecosystems are faring.

4)


Threatened Species Across the World: A Country-Wise View for 2024
United States of America: 39 species
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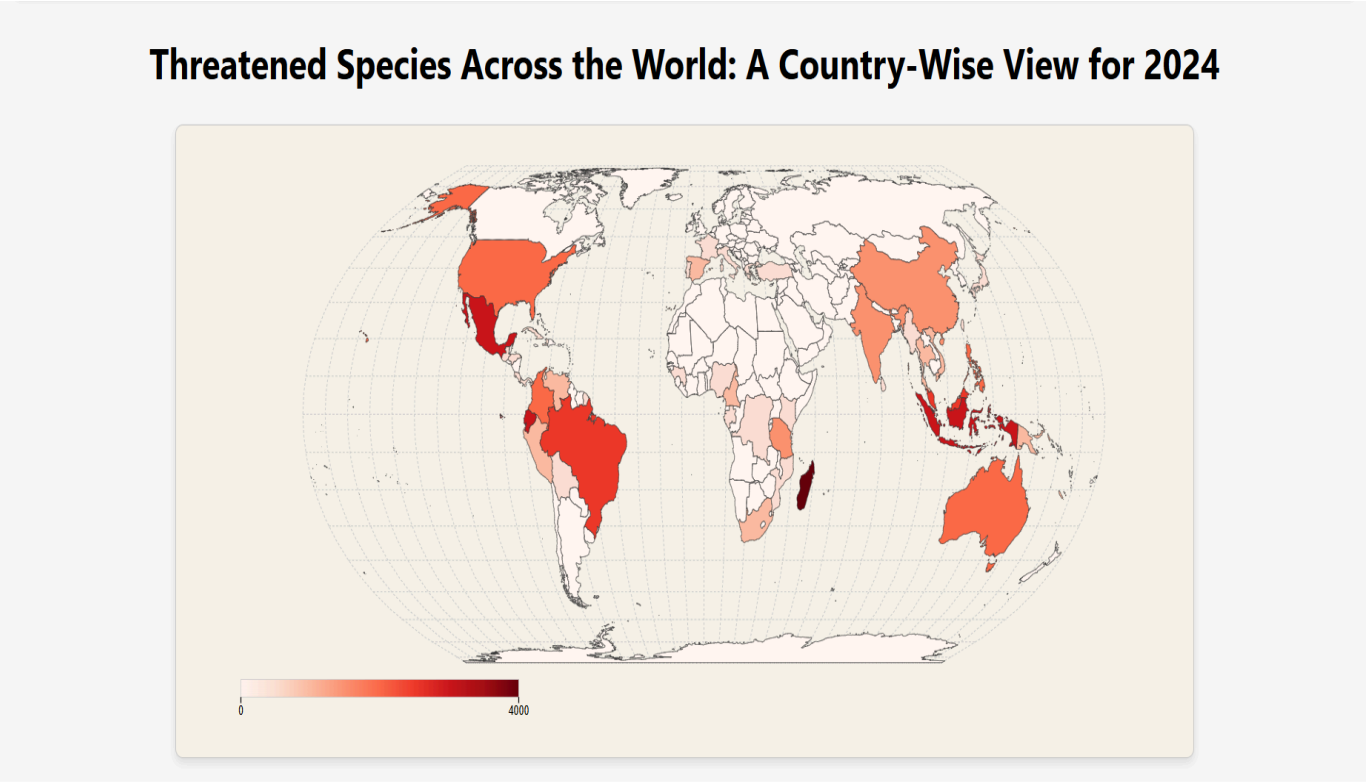
Threatened Species Across the World: A Country-Wise View for 2024
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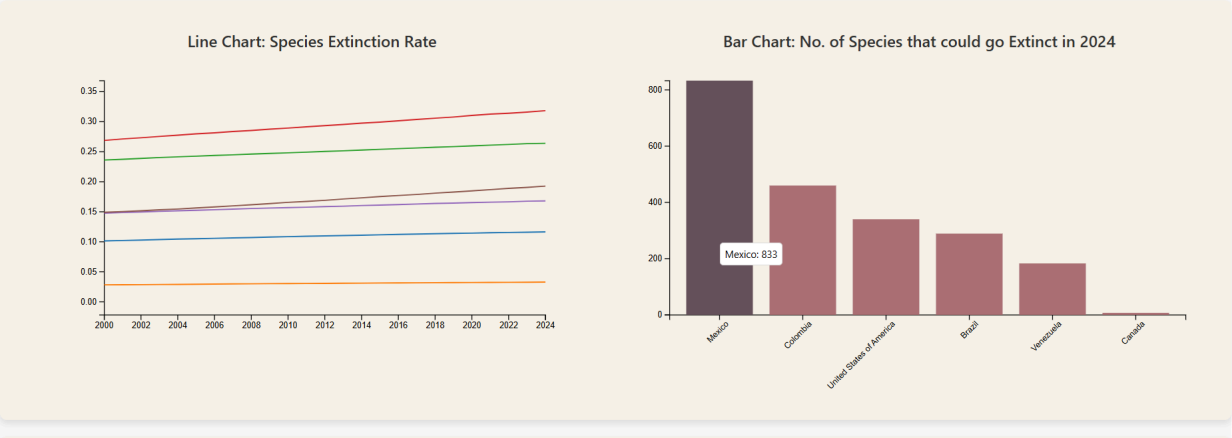
When a user hovers over any country on the map, the website dynamically displays the number of species in that country facing extinction. If no specific country is selected, the map shows the cumulative number of species at risk across the entire nation. This feature is designed to provide users with immediate feedback on the scale of extinction risks in each country. The hover function adds a layer of interactivity, engaging users and offering them a more hands-on way of exploring the data.

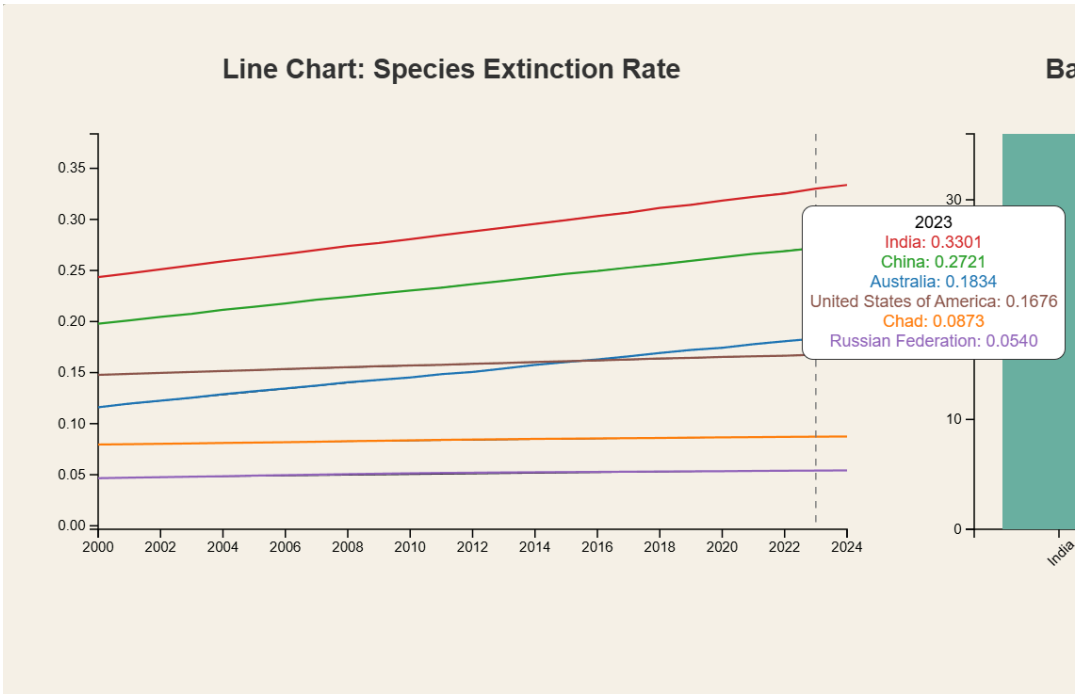
In the first image above, we selected a specific species from the drop-down list and we can see the number of that particular species in the region that we have selected. In the second image, we can see the number of all the species in that particular region.

5)

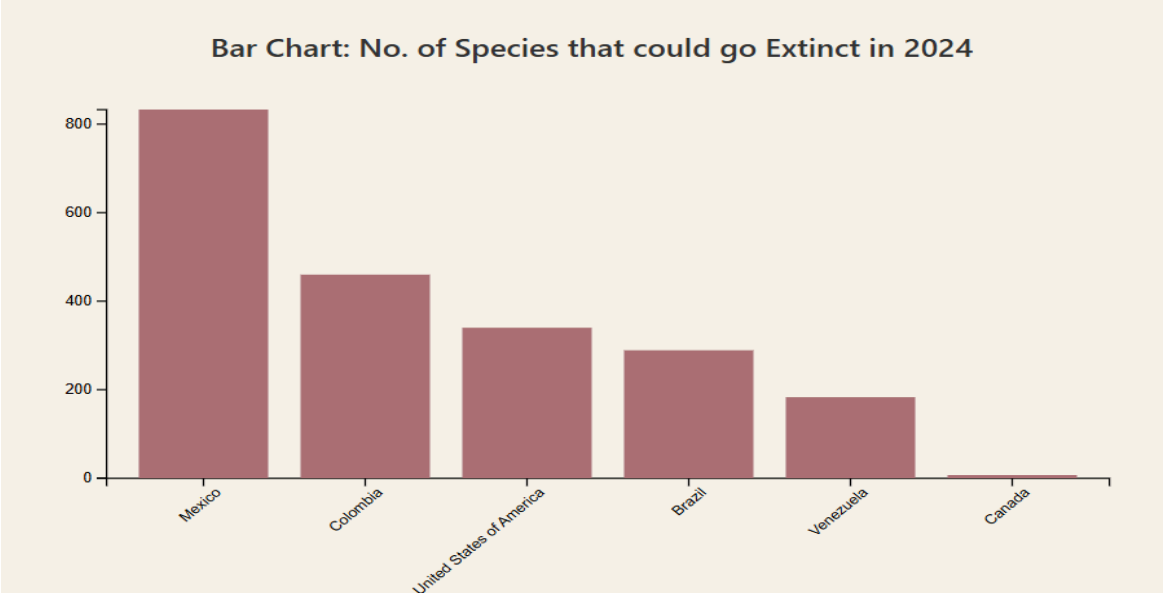


This image above of the website displays two types of charts: a line chart and a bar chart. The line chart tracks the rate of extinction of a selected species over time, showing how the threat to a particular species has grown or changed over the years. This feature helps users understand the historical context of extinction events. The bar chart, on the other hand, displays the number of species that could go extinct in 2024, offering a forecast of potential losses in the coming year. Together, these charts provide both historical and future perspectives on extinction risks, making it easier for users to grasp the urgency of the issue.

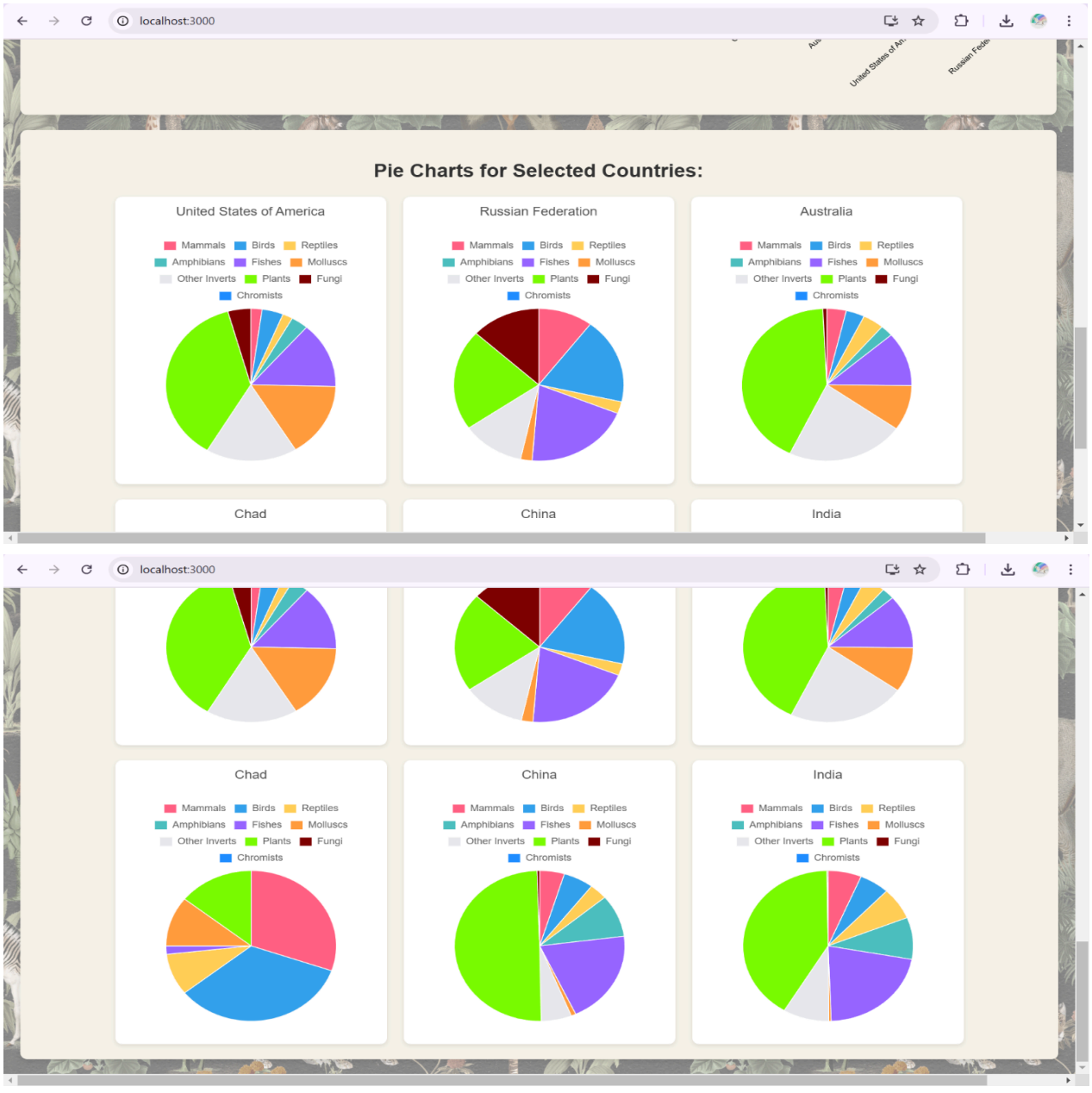
6) This feature allows users to interact with the line chart by hovering over specific years. When hovering over a given year, the extinction rate for that year is displayed. The chart adjusts in real-time, offering an intuitive way for users to examine how extinction rates change over time. This interaction adds another layer of user engagement, allowing individuals to explore data in a time-sensitive manner. The line chart dynamically updates, giving users a detailed view of how extinction rates evolved year by year.



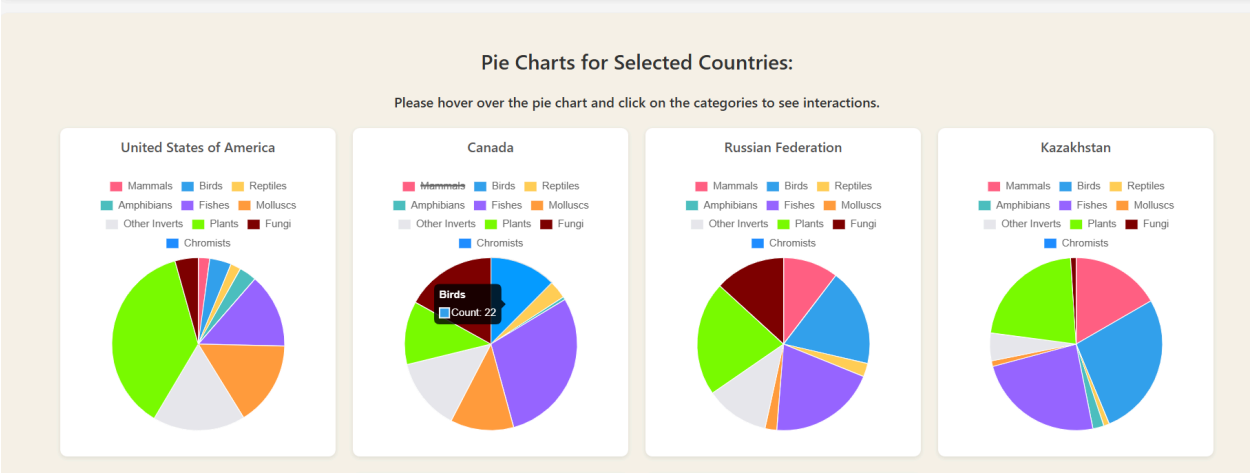
7) In the 7th image, the website displays bar charts for each country selected by the user. These charts reveal the predicted number of species that will go extinct, calculated using a formula: (Rate of Country) × (Number of Threatened Species). The bar chart offers an easy-to-understand visual representation of this data, allowing users to compare the projected extinction numbers across different countries. This section emphasizes how extinction predictions are made and highlights the countries that are most at risk.



8) This image introduces pie charts that display the breakdown of species within a selected country. Each pie chart is divided into sections representing different species categories, such as mammals, birds, reptiles, etc. These charts offer a detailed visualization of the biodiversity in that country and show how species are distributed across various groups. The pie charts allow users to easily compare which categories of species are most at risk and understand how the threat of extinction impacts different types of animals.

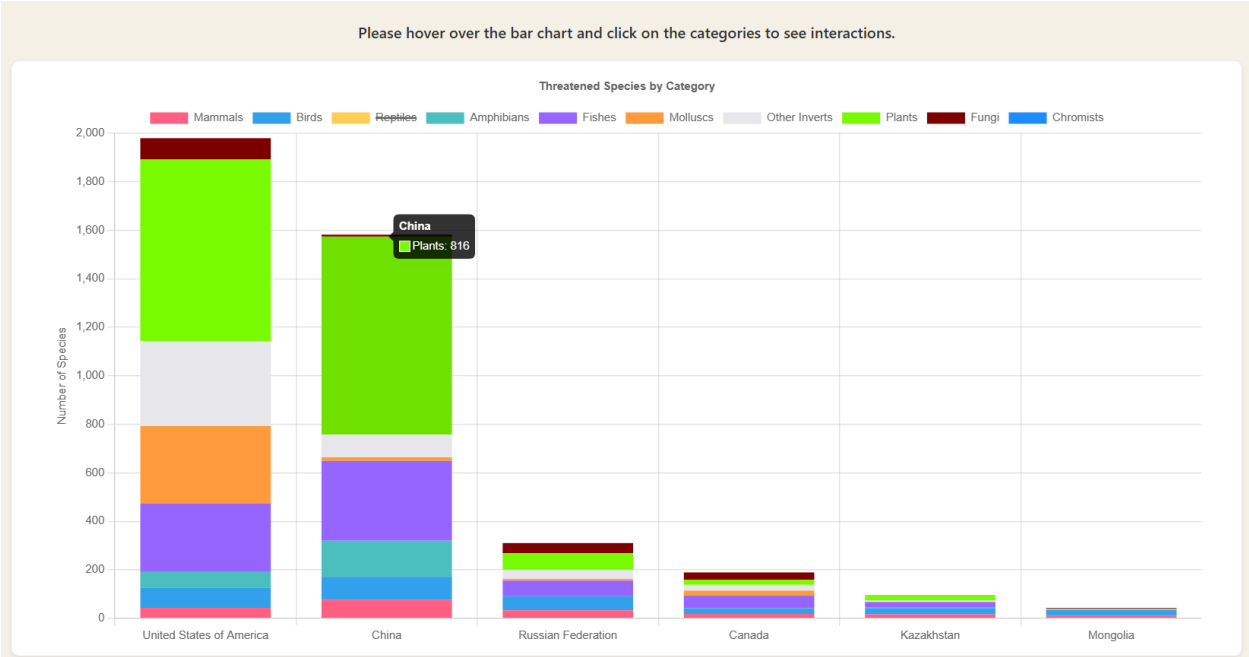


9) When users hover over any section of the pie chart, they are provided with a detailed view of the number of species at risk of extinction within that specific category. Moreover the user can click on a category label and that category will be removed as seen in canada mammals are removed. These features gives users a deeper understanding of how the extinction crisis is affecting specific types of animals, such as mammals or birds, and makes it easier to see the scale of the problem within each category.

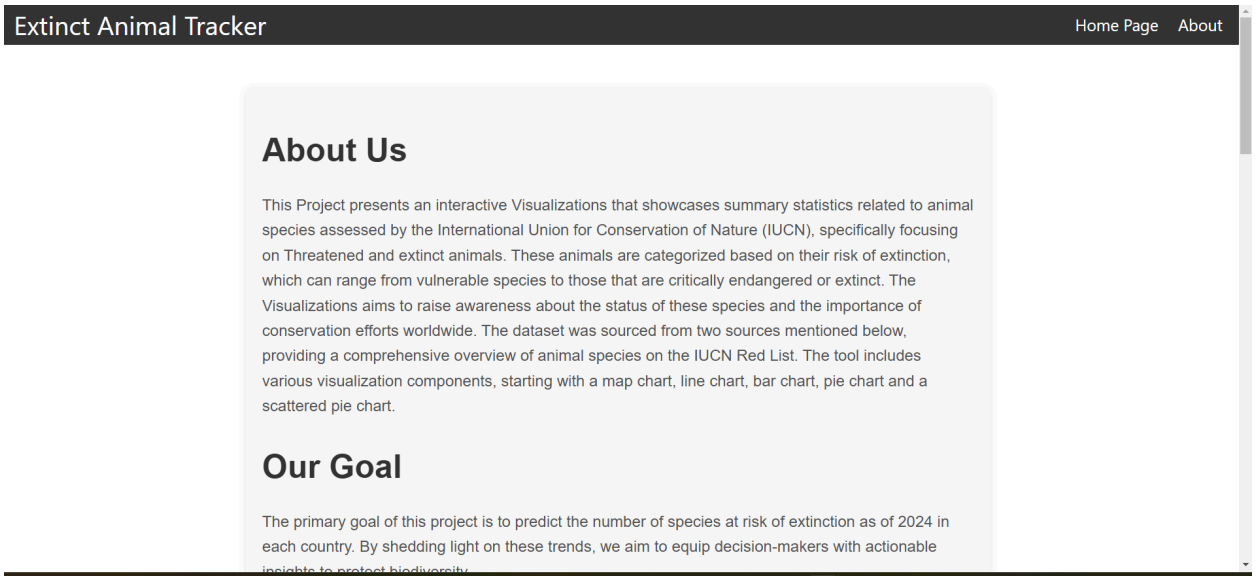


10)This visualization showcases stacked bar charts, highlighting the distribution of species in a selected country across various categories. Each bar is divided into sections that represent different species groups, including mammals, birds, reptiles, and others. The chart provides a clear and organized view of biodiversity within the region, enabling users to identify which species groups are most affected and how they compare to one another. Further similar to the pie chart here too a user can click on a category label at the top and the corresponding data from all the countries will be removed. Here we can see category reptiles have been removed.

An interactive hover feature allows users to delve deeper into the data. By hovering over a specific segment of the bar, detailed information is displayed about the exact number of species at risk in that category. This functionality brings the data to life, offering an engaging way to explore the impact of extinction threats on specific groups. The stacked bar chart not only presents a visually rich summary but also invites users to interact with the data for a more nuanced understanding of biodiversity challenges.



11)The final image shows the *About Us* page of the website, where we provide a concise overview of the project. This page introduces the core objectives of the *Extinct Animal Tracker* website: to raise awareness about endangered species and provide actionable insights into the ongoing biodiversity crisis. It explains the motivation behind the project and how it aims to educate and inspire users to take action in protecting our planet's wildlife. The *About Us* page is designed to give users a clear understanding of the project's mission and vision, setting the tone for the entire website.



Our Goal

The primary goal of this project is to predict the number of species at risk of extinction as of 2024 in each country. By shedding light on these trends, we aim to equip decision-makers with actionable insights to protect biodiversity.

Datasets

We utilized two critical datasets for this analysis:

- IUCN Red List: Threatened Species per Country Table 5a
- United Nations SDG Indicator 15.5.1: Red list Index

These datasets serve as the foundation for estimating trends and identifying countries with significant threats to biodiversity.

Visualizations

Our platform offers a comprehensive visual exploration of species data:

- **Map Chart:** The map visualization offers a global overview of countries with respect to their
- **Pie Charts:** The pie chart visualization provides a detailed breakdown of the different types of animal species at risk in a selected country. When a user clicks on a country, the pie chart appears below the map, illustrating the proportion of species categorized by type, such as mammals, birds, reptiles, amphibians, and fish. This chart helps users understand the diversity of species that are threatened within that country, offering a clear visual representation of the distribution of these species. It complements the map by allowing for a deeper dive into the specifics of species composition in each region.
- **Stacked Chart:** This graph provides a stacked bar chart visualization of the number of threatened species across various biological categories (e.g., Mammals, Birds, Reptiles) for selected countries. The data highlights the biodiversity challenges faced in different regions by presenting a breakdown of threatened species per category. Each bar represents a country, with segments showing the contribution of each category (e.g., Mammals, Plants) to the total number of threatened species. Further countries are arranged in descending order based on their total number of threatened species, emphasizing the most affected regions. The chart adapts to the selected countries, enabling focused analysis of specific regions of interest.

Through these tools, we aim to make data on species extinction accessible and actionable for everyone. If you have any questions or suggestions, feel free to reach out to us. Together, we can make a difference!