Visualizing Global Biodiversity and Animal Populations

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ABSTRACT

Biodiversity is essential for maintaining healthy ecosystems, yet many species face the threat of extinction due to human activities. Our research is motivated by a desire to preserve Earth's biodiversity and understand the impact of conservation efforts. We focus on tracking animal populations over time, particularly emphasizing endangered species to prevent their extinction. Amphibians, in particular, show the highest number of decreasing populations, highlighting the urgent need for conservation action. However, mammals and reptiles have experienced relatively fewer declines.

Using the Living Planet Index (LPI), a measure of global biodiversity based on population trends of various species, we analyze the state of the world's biological diversity. Since 1970, the LPI has shown a steady decrease, signaling the ongoing decline of global biodiversity. Notably, Latin America and the Caribbean exhibit the lowest LPI values, indicating significant biodiversity loss in these regions.

Our visualization dashboard aims to provide insights for policymakers to make informed decisions about environmental policy. By understanding trends and their implications, we can better address the challenges facing biodiversity conservation and work towards a sustainable future. Our findings are crucial for guiding conservation efforts and meeting the targets outlined by the Convention on Biological Diversity, particularly as we approach future environmental policy discussions.

1 INTRODUCTION

In our project, we would like to gain an understanding on the state of Earth's biodiversity. Biological diversity includes all living beings, not just the species categorized as endangered, and each living being plays a variety of important roles. Healthy ecosystems are dependent on biodiversity, which means we as humans are dependent as well. Ecosystems are where we get certain resources, like land, water, food, and shelter—all essential for our livelihood. This is in addition to the intrinsic and cultural values we have ascribed to nature.

However, human actions have been threatening biodiversity, leading to the unprecedented decline and extinction of animal populations and species. Therefore, it becomes important that we take on the responsibility to protect and increase Earth's biodiversity. An important step in this process is visualizing and analyzing data on animal populations to understand trends and patterns. Digging deeper, by identifying specific species and populations experiencing the most severe declines, we can focus conservation efforts where they are most needed. Moreover, it is just as important to pinpoint species and populations successfully recovering, so we can gather information on what is working and better inform future conservation efforts. Ongoing success stories also serve to show that there is impact and hope in the work we do.

2 RELATED LITERARY WORKS

We explored various literary works to provide a foundation of knowledge from which we can analyze our visualizations. These studies help us further support our conclusions and provide context for our findings.

2.1 Biodiversity and how it Impacts climate change

Biodiversity (also known as biological diversity) is the variety of life on Earth in all its forms, from genes and bacteria to entire ecosystems such as forests or coral reefs. The biodiversity we see today is the result of 4.5 billion years of evolution, which has been increasingly impacted by human life.

Human use of land, primarily for food production, is the main driver of biodiversity loss. We have already altered over 70% of all ice-free land.

Climate change also contributes to biodiversity decline, altering marine, terrestrial, and freshwater ecosystems around the world. In particular, it has caused the loss of local species, an increase in diseases, and mass mortality of plants and animals.

On land, higher temperatures force animals and plants to move to higher elevations and latitudes, damaging ecosystems. In the ocean, rising temperatures increase the irreversible loss of marine and coastal ecosystems. Half of live coral reefs have been destroyed in the past 150 years, and further warming threatens to destroy almost all remaining reefs.

These ecosystems and the biodiversity they contain are essential to limiting climate change as they are natural carbon sinks and can absorb the greenhouse gases we produce. Studying and conserving biodiversity is important to conserve nature and our future on this planet. [9]

2.2 How the Living Planet project helps us understand changes in the world's wildlife

Biodiversity is one of the hardest fields to gather data in–yet the Zoological Society of London (ZSL) and World Wildlife Fund (WWF) are taking on that challenge. Their database on more than 30,000 wildlife populations holds many stories to be interpreted and understood for the general public. The well-known 69% average decline from the Living Planet Index (LPI) tells only one part of the story. Rather, of all the taxonomic groups, around half of the populations are declining and the other half is growing. This narrows down where conservation efforts should be focused to half of the database. Additionally, digging only a little more into the specifics shows there are animal species and populations that are recovering through conservation efforts, which gives meaning to the work we do now and plan to do in the future. Identifying recovering and thriving animal populations also allows researchers to study them to understand why exactly their populations are doing better, which can inform future conservation efforts. Overall, rather than only focusing on the bigger picture, it is important to look further into the specifics of the database to understand what can be done for our future. [6]

2.3 Living Planet Index: what does an average decline of 69% really mean?

The Living Planet Index (LPI), specifically the world LPI, has often been misinterpreted by mainstream media. An average decline of 69% since 1970 of around 30,000 wildlife populations in the Living Planet Database (LPD) is shocking. Many have taken the average decline as the percentage of wildlife or animal populations lost. However, the LPI represents the average change in the number of individual animals in the dataset's animal populations, where different populations can be the same species in different geographical spaces. It is calculated by taking the geometric mean, rather than the arithmetic mean across animal populations. This misrepresentation affects the perception of the audience exposed to media, making it seem like decline and extinction are inevitable.

Furthermore, the LPI itself does not represent the full picture of biodiversity. Since it averages the changes in different populations together, we are unable to understand the state of each animal population. Each animal population is important to the ecosystem they live in, making targeted research and conservation necessary. The LPI has also been found to be sensitive to positive and negative outliers. Therefore, although the LPI is helpful, it is important to analyze and represent the LPD in more ways that are more intuitive to the general public. [7]

2.4 The diversity-weighted Living Planet Index: controlling for taxonomic bias in a global biodiversity indicator

Louise et al. discuss the urgent need for precise and unbiased measures of the impact of threats on global biodiversity. It highlights the limitations of existing indicators, which often rely on biased data from well-studied groups and regions, leading to misleading estimates of biodiversity trends. The study proposes an approach to mitigate taxonomic and geographic bias in the Living Planet Index (LPI), a key indicator of biodiversity trends. The researchers estimated global decline in various species by accounting for the estimated number of species within biogeographical realms and their relative diversity. Their findings emphasize the severity of biodiversity decline and suggest that species with poorer data coverage may be declining even more rapidly. This study provides crucial insights into the state of global biodiversity and emphasizes the importance of unbiased data in accurately assessing and addressing biodiversity loss. [5]

2.5 Clustered versus catastrophic global vertebrate declines

Leung et al. scrutinize the 69% average decline found through the Living Planet Index (LPI) by looking closer at the outliers included in the analysis. The high decline is largely influenced by less than 3% of the animal populations in the database, due to their extreme loss. If excluded from consideration, the average becomes an increase. From this discovery, Leung et al. propose another approach that identifies clusters of extreme population change from the overall trends. Their approach identified three taxonomic-geographic systems in the Indo-Pacific region strongly declining with high certainty as well as seven systems of the reptile and amphibian groups strongly declining with less certainty. With this knowledge, researchers and conservationists can focus their work on the animal species and populations truly experiencing loss. This study supports the hypothesis that the 69% average decline is due to clustered declines from certain animal populations, rather than catastrophic declines from wide-spread loss in many animal populations. [3]

2.6 Data analysis in monitoring

This excerpt from "Monitoring Animal Populations and their Habitats: A Practitioner's Guide" analyzes the various methods of data analysis used for the monitoring of animal populations and habitats. McComb et al. outline the first two steps necessary for creating data visualizations: 'Getting to know your Data' and 'Getting to know your model.' The first phase involves exploratory data evaluation, or experimenting with graphs, plots, bar charts, and other visualization methods to represent the data truthfully and encourage the user to think about the data. The different methods of data evaluation range from plotting sampling curves to using log models–this depends on what the data requires. The second step involves fully understanding your model–this can be achieved through updating your visualizations to decide whether the relationships you see are valid. For example, you can check for auto-correlation in scatter plots by including residual points and plot residuals alongside predicted values to detect any violations in homoscedasticity. An important conclusion in this section was that ecological data rarely follows a normal distribution, so we should be prepared to make modifications.

In addition to the highlighted steps, McComb et al. identify various other data analysis methods that are particularly useful for exploring animal populations. One of these is using population size, which is helpful for assessing characteristics such as population status and trends as these parameters are known to fluctuate often due to factors such as mortality, exploitation, and habitat quality. Another point McComb et al. emphasized was that looking at species occurrences and distributions can highlight the habitats that contain the richest communities and hold the highest number of species, which could be crucial for conservation research. Lastly, analyzing trends in animal population data could identify environmental variables contributing to population decline as well as evaluate the effectiveness of policy decisions regarding biodiversity. [4]

2.7 Toward the next common agricultural policy reform: determinants of avian communities in hay meadows reveal current policy's inadequacy for biodiversity conservation in grassland ecosystems

This study investigated avian communities in semi-natural grasslands, which have been severely impacted by farming and land abandonment. The European Union has implemented CAP (Common Agricultural Policy) that includes "greening" measures intended to conserve the grasslands, but its effectiveness still remains to be seen. The researchers surveyed birds in 63 landscape units in Italy and highlighted how the number of different bird species decreased in areas with heavily farmed meadows. In particular, spatial factors (such as where the birds were located) were the most important for the types of birds found, explaining about 41% of the variability. Landscape and topography factors were also important and closely linked with each other, explaining around 35% of the number of different bird species. Human management (such as how the meadows were cared for and whether they were mowed early) influenced the number of birds that preferred meadows in addition to the land's topography (particularly elevation).

By keeping track of animal populations and general changes in biodiversity, we can analyze the effectiveness of policies such as CAP and how to better iterate on them in the future. [1]

2.8 Species extinction and conservation status

This data story, "Species Extinction and Conservation Status," is a student work written by Michelle Kung at the Pratt Institute School of Information. Kung was inspired by two visualizations: firstly, a line plot created by the Living Planet Index which depicted the average drop in population sizes of mammals, birds, fish, amphibians, and reptiles over time. Kung was also inspired by a species sphere created using the CITIES Trade Database portraying the illegal trade of protected animals. Kung explored data from the UN environmental database to further explore these relationships. However, this dataset implied that threatened species were improving, which did not seem believable. Therefore, Kung implemented the IUCN's Red List to create two dashboards containing visualizations from Tableau. Her first dashboard contained a line graph depicting an increase in the total number number of threatened organisms, another line graph depicting the decrease in percentage of threatened species, and a pie chart of all threatened species. To further explore these relationships, Kung created a second dashboard holding a line plot of the rise in extinct species from 2010 to 2019 as well as a parallel line plot of the conservation status for invertebrates, plants, and vertebrate. In order to quantify the category of conservation status, she converted it to numbers, where 1 represented those of least concern and 8 represented extinction. Kung's conclusion was that data collection can be a messy process, and this depends on the data you are working with. She also found that Tableau was helpful for unearthing trends in the data, which helped to highlight graphs that had little correlation and/or visual impact. [2]

3 Project Description

Our biodiversity visualization dashboard offers comprehensive insight into the status and changes of animal populations across the globe. By integrating various visualization techniques, the dashboard provides a multifaceted exploration of biodiversity trends from 1950 to 2020. Through interactive maps, charts, and filters, users can delve into the dynamics of wildlife populations, identify trends, and discern patterns crucial for informed decision-making and environmental policy formulation.

We utilized extensive datasets, Living Planet Index (LPI) and Living Planet Database (LPD), provided by the Living Planet Project to analyze animal populations and biodiversity trends comprehensively. The data comes from a compilation of scientific articles, online databases, and government reports. The most recent 2022 report includes 31,821 wildlife populations and around 5,230 species—all vertebrate species. It is important to note that the datasets contain only a small portion of the world's animal populations, and do not represent the entire globe equally, as some regions have more data. [8]

By incorporating LPI and LPD data into our visualizations, we gained invaluable insights into the health and trajectories of various animal populations over time. Leveraging this dataset, we were able to identify thriving animals that do not require immediate intervention, as well as those facing significant declines and needing urgent protection measures. Through careful analysis of LPD data, we pinpointed several animal species demonstrating positive population trends, indicating successful conservation efforts or favorable ecological conditions. Conversely, we identified animal classes experiencing declines, signaling areas of concern and the necessity for proactive conservation strategies. This utilization of the data from LPI and LPD enhances our understanding of global biodiversity patterns and allows policymakers and conservationists to prioritize resources and enact targeted measures to protect vulnerable species and ecosystems. [6]

3.1 Explore animal population locations over time

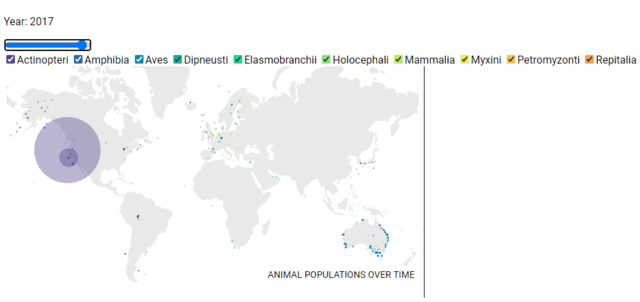

Figure 1: A visualization of the data from the Living Planet Database generated in D3.

Description This visualization was developed in D3 and displays animal populations on a world map. It has a slider where you can explore the distributions of animal populations over the years from 1950 to 2020. You can also filter by animal class so you can better investigate the distributions of specific animal groups (especially since the fish populations dominate the overall visualization).

Justification This world map graph displaying animal distributions and locations over time is invaluable for tracking animal populations and understanding biodiversity trends. By visualizing the spatial distribution of various animal species, we gain insights into their habitats, migration patterns, and population densities. The slider feature allows us to observe changes over time, revealing population size and distribution shifts. The size of each circle represents the number of animals in a particular area, providing a clear depiction of population density. This tool aids conservation efforts by highlighting regions with declining populations or habitats under threat, allowing for targeted conservation strategies. Furthermore, by filtering by animal class, researchers can focus on specific groups, such as mammals, birds, reptiles, or amphibians, to analyze trends within each class. Understanding how animal populations change over time helps us assess the health of ecosystems, identify areas in need of protection, and monitor the effectiveness of conservation measures. Ultimately, this map contributes to the preservation of biodiversity by providing crucial data for informed decision-making and conservation planning.

Findings In 1950, at the beginning, we can see that there are large animal populations of the Actinopteri (i.e., fish) class in North and Central America, and the populations continue to grow larger and in other regions through the years. Looking at more recent years, the populations of Actinopteri class mostly moved to the west coast and elsewhere. However, it seems like this could be more the result of the database lacking updated data from 2010 and onward, from the previous visualization. It is interesting slowly moving through the years to see certain animal populations grow, decline, and disappear altogether. This can point researchers and conservationists to areas of interest. Additionally, we can see that a lot of the animal population clusters are around North and Central America, as well as Europe. This is indicative of the data from LPD not being representative of other regions, like South America, Africa, and Asia, which are regions where there is a lot more biodiversity.

3.2 Explore wildlife populations by common name over time

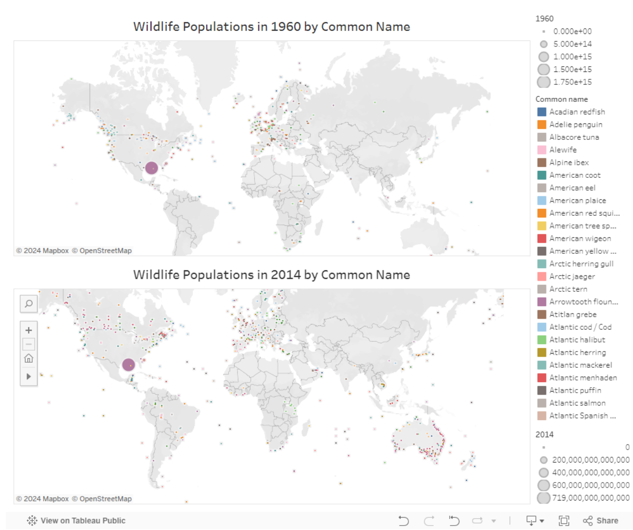

Figure 2: A visualization of the data from the Living Planet Database generated in Tableau.

Description This visualization was developed in Tableau and depicts wildlife populations on the world map between 1960 and 2014. The populations are grouped by Common Name, which is set apart using color. Moreover, the number of animals observed in each recording is quantified using scale or a proportionately sized encoding. The parallel nature of these two maps allows the viewer to compare populations across the two endpoints of the data easily.

Justification These parallel world maps are helpful in further visualizing the spread and patterns of animal populations over the years. By selecting data from two endpoints of the Living Planet Database data, we enable the viewer to closely examine the trends in animal migration and habitation over time. Thanks to the interactive, scroll-and-zoom options that Tableau provides, researchers will be able to navigate to certain countries and regions that they are most interested in exploring. Moreover, the use of color and size on the map to distinguish between population size and common name will allow the viewer to seamlessly analyze animal migration and habitation patterns, as well as changes in population, over the years. This could enable researchers to identify the animals that require more conservation efforts, so they can divert more resources to support them. Moreover, researchers can identify which countries and regions have the greatest and least diversity of a certain animal, using our map, which can allow them to make better-informed policy decisions.

Findings Right away, we can see that there are many more animal population clusters in 2014 than in 1960, which means that the data has become more representative of other regions, especially South America and Australia. However, the increase should not be interpreted as there being an increase in number of animals and animal populations, as there has been an average decline of 69% of animal populations. It is hard to pinpoint specific findings with this visualization, as each researcher or conservationist may find interest in different regions and animal populations.

3.3 Explore how wildlife populations are changing over time

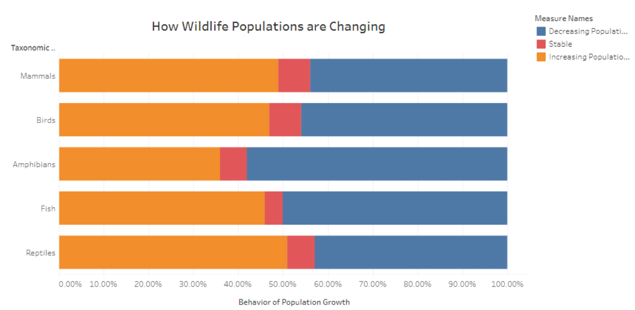

Figure 3: A visualization of the data from the Living Planet Database generated in Tableau.

Description This visualization was also developed in Tableau and portrays how wildlife populations are changing over time, using multiple horizontal bar charts. There are distinct bar charts for each Taxonomic group, and each bar chart is divided into increasing, stable, and decreasing populations. Each division in the bar chart (increasing, stable, or decreasing) is delineated by a unique color.

Justification In order to understand which animal groups hold the highest risk of endangerment, it is important to visualize trends in populations as a whole. This visualization achieves this by representing our data in a parallel manner, allowing the viewer to easily differentiate between the growth and decline of the different groups of animals. Researchers can use this visualization as a stepping stone to decide which group of animals requires the most intervention and support. For example, those with a higher proportion of decreasing populations should require more focus than those who are mostly increasing or stable.

Findings From the bar chart, around half of the animal populations in each class are decreasing, while the other half is increasing. Otherwise, there is a small percentage of the populations staying stable. The class of animals, compared to the rest of the classes, that shows the most decreasing than increasing is amphibians. Next are fishes, birds, mammals, and reptiles. In addition to the need for more data collection, there needs to be more focus in conservation efforts for amphibians.

3.4 Living Planet Index over time and by region

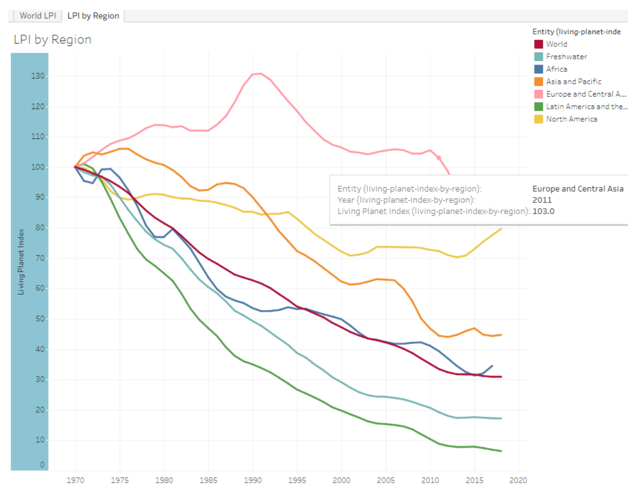

Figure 4: A visualization of the data from the Living Planet Index generated in Tableau.

Description This visualization was developed in Tableau. It depicts the Living Planet Index (LPI), a percentage, through line graphs for the world and for different regions on different tabs. For the World LPI graph, the middle line is the LPI from 1970 to 2018, while the lines below and above show the lower and upper confidence intervals, respectively. For the LPI by Region graph, there are separate lines for comparison of the world and different regions over time: freshwater, Africa, Asian and Pacific, Europe and Central Asia, Latin America and the Caribbean, and North America.

Justification The Living Planet Index (LPI) is a measure on the state of the world's biological diversity based on population trends of vertebrate species from terrestrial, freshwater and marine habitats. This measure helps us understand the world's biodiversity as a whole. However, the world LPI can be too general, as it does not tell us any specifics on animal populations or species, which is why the other tab gives the LPI for different regions.

Findings Once the LPI is given for different regions, we can pinpoint specific regions to focus conservation efforts on, such as Latin American and the Caribbean region and the freshwater region. There, the average decline is much worse than even the world LPI, so research and conservation should be focused on animal populations there. For the regions doing better than the World LPI decline, it would be important to study why their conservation efforts are working. Specifically, regions of interest would be Europe and Central Asia for the peak in 1991, as well as North America for their increase since 2014.

3.5 Number of species by animal class in database

Description This visualization was developed using Altair. The pie chart shows the number of species in each animal class in the Living Planet Database (LPD). We can see the distribution of species among each animal class and understand the LPD's representation of

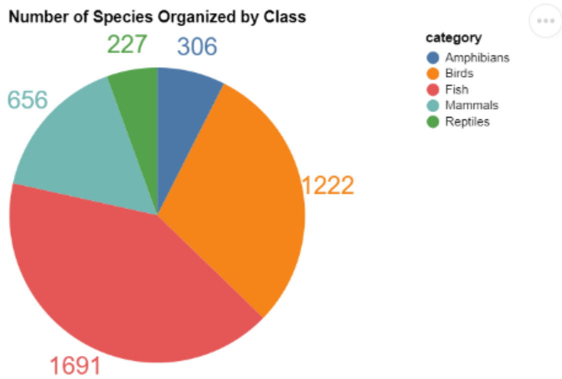

Figure 5: A visualization of the data from the Living Planet Database generated in Altair.

animal classes. With this information, we can prioritize the animal classes accordingly. This visualization will help us evaluate the biodiversity within ecosystems, as well as where there is missing data.

Justification Understanding each animal class and how each species contributes to its environment is paramount in creating effective conservation policies. This visual representation offers a clear overview of the distribution of species across different classes like mammals, birds, reptiles, amphibians, and fish in the database. Conservation efforts can be targeted effectively by knowing which animal classes are most diverse or most threatened. To get to this knowledge, it is important to analyze the source of the data and identify where there is a lack of data for certain species and animal classes.

Findings The majority of species in the database are fish, then birds, mammals, amphibians, and, lastly, reptiles. Of the identified species so far, the classes—ordered by the most to least species—are fishes, reptiles, birds, amphibians, and mammals. From this, it seems that amphibians and reptiles are underrepresented in the LPD. We can also highlight that none of the animal species nor classes include invertebrates, which are also important for biodiversity and ecosystems. Overall, there are millions of species unaccounted for in the database of only a few thousand species, so the conclusions drawn through our visualizations and analysis only go so far in understanding the state of biodiversity today.

3.6 Explore increase in numbers of animal populations over time

Description This visualization was developed in Altair and depicts the 20 animals in the world with the greatest increase in population. This is portrayed using a horizontal bar chart, where each bar represents an animal by their Common Name in the data. The bars are ordered by descending percentage of average relative change in population size, and an Altair color scheme is used to depict the magnitude in change. Moreover, a logarithmic scale and tooltip are implemented to make viewing easier for the reader.

Justification By manipulating data from our Living Planet Database (LPD), we are able to show researchers exactly which species are experiencing the most growth, across two different points in time. These species are highlighted so that researchers can study their context, such as their characteristics, conservation work, and more, to understand why they are experiencing the largest increase in population. This could be due to a variety of factors, all of which could be implemented to create better conservation methods for threatened or endangered species and populations.

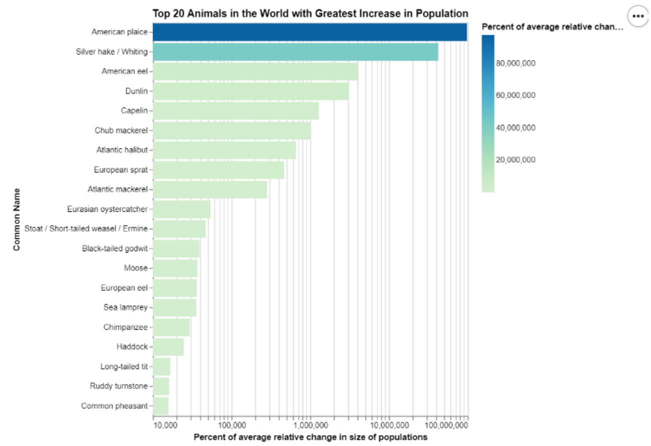

Figure 6: A visualization of the data from the Living Planet Database generated in Altair.

Findings The top three species are the American plaice, silver hake/ whiting, and American eel, which are all part of classes of fish. It seems that it is mostly fish species making the largest increases in animal population, due to conservation efforts as well as their ability to multiply frequently. We also see representation of mammals, with weasels, moose, and chimpanzees. These species are the ones we can look to for hope and research on working conservation efforts.

3.7 Explore decrease in numbers of animal populations over time

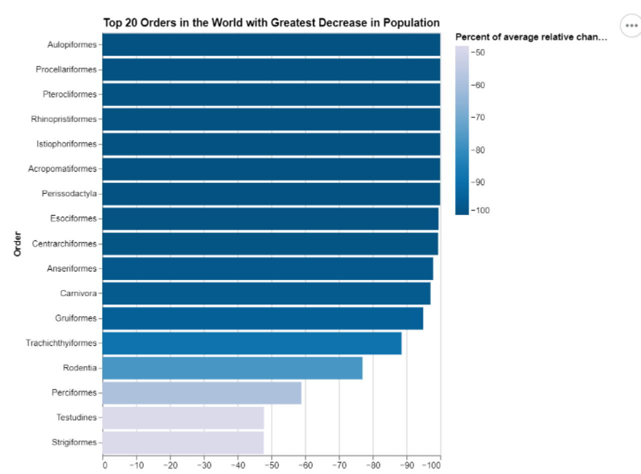

Figure 7: A visualization of the data from the Living Planet Database generated in Altair.

Description This visualization was developed in Altair and depicts the 20 animals in the world with the greatest decrease in population. This is portrayed using a horizontal bar chart, where each bar represents an Order of animals in the data. The bar charts are ordered by ascending percent of average relative change in size of populations, and an Altair color scheme is used to depict the magnitude in change. Moreover, a tooltip is implemented to make viewing easier for the reader.

Justification This visualization uses data from the Living Planet Database (LPD), but focuses on animal orders with the greatest decrease in population. This enables researchers to narrow down and determine which species require the most intervention and support, and allows them to explore similar patterns that are causing each order to experience a decline. This can help further their knowledge of biodiversity patterns as well as benefit the animals that are in endangerment.

Findings The top five orders in this visualization are the Aulopiformes, Procellariformes, Pterocliformes, Rhinopristiformes, and Istiophoriformes, where the three are a type of fish and two are a type of bird. This is interesting because amphibians are the ones experiencing the largest percentage of decreasing populations, then it is fishes and birds. However, this is probably because fish and bird populations just have a higher number of individuals in general. Therefore, it could be more helpful to compare number of animals in a population by species within the same classes, rather than by orders or species.

3.8 Explore number of populations and species over time in database

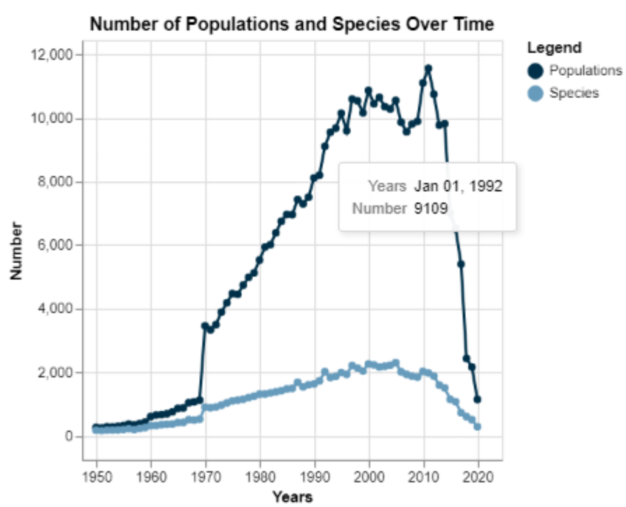

Figure 8: A visualization of the data from the Living Planet Database generated in Altair.

Description This visualization was developed in Altair, and it shows how the number of animal populations and species represented in the Living Planet Database (LPD) has changed over time. Both increased from 1950 to 2011, but have steadily decreased since then. The visualization also includes a tooltip that allows you to pinpoint more specific data points while allowing you to look at the changes as a whole.

Justification It is important to understand the representation of populations and species in the database, which is why we looked into their records over time. We decided on a line graph to understand the trends over the years for the data, as well as see if there were any trends between number of populations and species being represented.

Findings The number of populations and species which have a data point in a given year rises steadily from 1970, reaching a peak of greater than 18,000 and 3,100—respectively—in the late 1990s and early 2000s. After this point, numbers drop rapidly. As research on wildlife population change is still ongoing in more recent years, this reduction in the number of contributing populations and species is mainly due to a lag in the publication of collected data. In addition, data is published at a rate that creates a backlog of time-series data to be entered into the database, and newer data sources are unlikely to be added unless they are in line with the current focus of data collection. This is important to represent and understand about the LPD, as it means the conclusions we draw through our visualizations show an incomplete story. While the number of represented animal populations and species has increased, there are still many missing, especially updated data in the years after 2011.

4 Discussion

4.1 Biodiversity and conservation

Biodiversity is the foundation of healthy ecosystems, providing resources essential for human survival. Our analysis shows the urgent need for conservation efforts, particularly focusing on endangered species to prevent their extinction. The alarming decline in amphibian populations emphasizes the importance of targeted conservation action and policies. While mammals and reptiles show relatively fewer declines, the overall trend in global biodiversity, measured by the Living Planet Index (LPI), is concerning. By identifying species experiencing severe declines and those successfully recovering, we provide valuable insights for conservation strategies. Additionally, recognizing regions with significant biodiversity loss, such as Latin America and the Caribbean, highlights areas where conservation measures should be focused.

4.2 Current biodiversity trends

Our literature review provides important insight for understanding the factors that influence biodiversity decline. Human activities, particularly land use and climate change, are key drivers of biodiversity loss. The Living Planet Database offers insights into global wildlife populations and biodiversity trends that we can use to better understand the effects of current conservation efforts and how to change them for the better. The misinterpretation of the Living Planet Index has led to misconceptions about the severity of biodiversity decline. However, studies such as those by Leung et al. and Louise et al. help clarify the nuances of this decline, identifying specific clusters of extreme population change and proposing methods to mitigate bias in global biodiversity indicators.

4.3 Importance of visualization

Our visualization dashboard can be a useful tool for policymakers and researchers to understand and address biodiversity challenges. By tracking animal populations over time and visualizing their distributions, trends, and changes, our visualizations offer insights for targeted conservation efforts. The interactive maps and charts enable users to explore biodiversity patterns globally and regionally, identifying areas and species of concern. Additionally, visualizations of population and species changes over time highlight key trends. Our visualizations help us understand our current biodiversity and inform future conservation efforts and policies.

4.4 Limitations and future research

The Living Planet Database, while extensive, does not represent the entire globe equally, with some regions having more data than others. Additionally, our visualizations primarily focus on vertebrate species, potentially overlooking important trends in invertebrate populations. Future research could explore ways to incorporate more comprehensive datasets, including invertebrates and other regions (like the tropics) that are currently less accessible. Additionally, expanding our visualizations to include socioeconomic and policy-related factors could provide a more holistic understanding of biodiversity decline and improve conservation strategies.

5 Conclusion

Our visualizations and findings are only a start to understanding the state of biodiversity today. There is a need for more data collection in order to more accurately identify animal populations and species in need of intervention, for focused conservation work. Additionally, this would lead to better informed policies that target where attention is needed. Although there is more work to be done, we have hope for the future, as there are many animal populations and species already recovering due to human conservation efforts.

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