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An Anthropogenic Mass Extinction: Speculation about the Future of Humanity and Other Species

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Abstract

This thesis will address the possibility of a sixth mass extinction at the hands of humanity and the adaptations ecosystems may undertake in recovery. Today, the world is witnessing incredibly fast changes in climate conditions that are causing severe biodiversity loss. Haiti is a region that encompasses the impacts of both environmental degradation and humanity's social influences on the environment. Haiti will be examined throughout this thesis to provide an understanding of how climate change impacts people and the natural world today. Non-anthropogenic rapid climate change is the root of most past mass extinctions. However, after these events, ecosystems have recovered, and the niches of lost species have been filled, giving way to new environmental makeups. The first chapter will examine qualitative and quantitative data that suggests a coming mass extinction with the effects of human society's habits on the natural world and how this is characteristic of a mass extinction event. The current and speculative future rates of extinction will be examined along with the adaptations of wildlife today in a world dominated by humans. The second chapter will use a historical lens to focus on the five past global mass extinctions, considering the causes and aftermaths of these events. The fall of past human civilizations due to environmental degradation and the history of the Anthropocene will be examined. The third chapter will use evolutionary biology and sociology disciplines to examine the speculation of a society and an Earth in the case of anthropogenic mass extinction, contextualized by accelerating climate change. Future changes in evolution and ecosystems due to human activity will be discussed to gain perspective on how extreme human impacts are on nature. Speculation of societies, infrastructures, and more will also be addressed through the effects of climate change. The fourth chapter will discuss political aspects and contemporary governments' measures to avoid mass extinction under modern environmental conditions. The fifth chapter will recommend

a policy prioritizing endangered plant and animal species conservation, conservation, and environmental education. Countries that are currently in climate crises will also be prioritized. At the same time, the use of gas, oil, plastics, and more damaging habits will transition into sustainable practices that can support humanity and the living environment.

Keywords: evolutionary speculation, mass extinction, evolution, environmental justice, Anthropocene, conservation, mitigation, adaptation

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Introduction: Evolution and the Anthropocene

Charles Darwin defined evolution as "descent with modification." Essentially, this means that over long periods, species change through adaptation and eventually give way to the rise of new species. Though what drives adaptation? Significant environmental changes that prevent species' ability to thrive under altered conditions lead to adaptation. Those species that cannot change will eventually go extinct, while fit species will replace their niches. Darwin's theory of Natural Selection claims that the species with the most suitable characteristics to their environment will continue to thrive while the rest are weaned out. This *should* mean that the plants and animals we see in the current environment are best adapted to thrive under modern conditions. This, unfortunately, is no longer the case. The global temperature is rising, sea levels are rising, the atmospheric makeup is changing, and other alterations to the environment are happening incredibly fast. Although Darwin's theories of evolution and natural selection remain widely respected, most species will not have adequate time to endure the destruction of the environment at the hands of humanity.

What adaptation doesn't require, though, is stability. The most significant changes in ecology and biodiversity have been seen after mass extinction events. For example, during the End-Permian extinction, 95% of previous species went extinct (ZSL, 2023). Afterward, the biodiversity was eventually restored within millions of years. Although there continue to be many questions about what exactly caused the End-Permian extinction, there is no question that this event and what is happening today are similar in that they both see massive biodiversity loss. Global environmental conditions are changing too rapidly to support the current life on Earth. Therefore, the species once fit for the Holocene are no longer able to survive in this new, unfamiliar environment.

This unknown environment has become known as the Anthropocene, or the geological time unit of rapid climate change dominated by humans – contrary to the Holocene, which was a period of climatic stability. The Anthropocene is nearly the opposite of climatic stability. It is marked by rapid climate change, amongst other characteristics. The World Wildlife Fund (WWF) and Zoological Society of London's Living Planet Report claim that wildlife populations have decreased by an average of 69% in less than 50 years (WWF, 2022). This alarming rate of loss in animal populations is one important attribute of the Anthropocene, suggesting a path toward anthropogenic mass extinction. Another essential characteristic of the current epoch is the ways in which humanity dominates the environment. Nuclear weapons, methane gas, CO2, fossil fuels, and more aspects that alter the atmosphere are changing evolutionary tracks today, as seen in Chernobyl. What does this mean for the future of the environment? How will humanity impact the future evolutions of species today and those to come? Although many current species are on track to go extinct, those that can adapt to the conditions of the Anthropocene may become the ancestors of a new, biodiverse, ecologically dense Earth in the coming millions of years.

Darwin's theories of evolution and Natural Selection highlight the adaptability of nature when faced with exceptional circumstances. The Anthropocene represents a time of extremely rapid climate change, a change which nature will come to adjust to in the future. This thesis will examine the Anthropocene's likelihood of mass extinction as well as speculative ways in which ecosystems will manage to recover with time. The first chapter will contain qualitative and quantitative data that suggests an anthropogenic mass extinction, including current and speculative future extinction rates. The second chapter will delve into environmental history while examining the five past global mass extinctions, their causes and effects on ecology, and the similarities and differences to the conditions of the Anthropocene. With a sociological lens,

the third chapter will discuss society's anxiety of mass extinction, as well as speculation of human society's future. The fourth chapter will look into the political aspects of climate change and the attempts to prevent or endure a modern mass extinction. Finally, the fifth chapter will recommend a policy that will work to avert anthropogenic mass extinction and to prepare humanity for the future impacts of climate change.

Chapter 1: Data Suggesting Mass Extinction

This chapter will first use qualitative and quantitative data to examine the relationships between the rising extinction rate, humanity, and ecosystem services. Then, extinction rates around the globe will be discussed in the context of both climate change and mass extinction, as well as the causes. The third section will examine how these extinction rates are projected to rise and what that means for the future of the Anthropocene. Finally, this chapter will put these numbers into a regional context in Haiti, which is seeing extinction very rapidly and destructively.

Ecosystem Services and Extinction. The rising extinction trends suggest a path toward a sixth mass extinction. With a steady background extinction rate, ecosystems are able to support rich and evolving biodiversity. Thus, ecosystems are able to continue to provide the services required for the well-being of humanity. With rising extinction rates, the functioning of these ecosystems is altered and therefore becomes dysfunctional, affecting nature's ability to provide humanity with needed ecosystem services. These ecosystem services, which are the benefits humans, societies, and civilizations receive from ecosystems, continually flow and function as a result of a healthy and stable climate. Humanity depends entirely on these ecosystems, whether remote and undisturbed or cultivated and urbanized.

There are four ecosystem services highlighted and detailed by the Millennium Ecosystem Assessment. First, *Provisioning* services, the energy and material outputs of an ecosystem, involve providing humanity with food, water, oil, medicine, and other raw materials. Though with rising extinction rates, there is less variation of wild edible plant and animal foods, while industrial agriculture is destroying ecosystems. The inappropriate anthropogenic uses of provisioning resources, such as extraction, water, and air pollution, further cause extinction and

fewer resources available to humans. *Regulating* allows for a stable climate in which humans can safely exist without the imminent threat of disease and toxicity. Rapid climate changes are making the atmosphere less and less fit for humans, along with other species with which we share the Earth. *Cultural* ecosystem services, which provide nonmaterial benefits to humans whether they involve spirituality, mental health benefits, reflection, and other aspects that are essential to cultural enrichment, are also vanishing due to a lack of appreciation for nature as well as the disappearing of forests and natural areas. Finally, *supporting* ecosystem services are necessary for all other ecosystem services to function. This includes healthy and rich biodiversity, nutrient cycling, and primary production sources. They are affected by rising extinction levels because biodiversity, healthy atmospheric conditions, and a stable climate are all necessary for ecosystems to support humanity. With healthy supporting ecosystem services, all others are able to function with stability and harmony, though with a lack of healthy supporting services all others are impacted. " Half of provisioning services (6 of 11) and nearly 70% (9 of 13) of regulating and cultural services are being degraded or used unsustainably." (Millenium Ecosystems Assessment Boards, 2005, 39) These four services then permit the constituents of human well-being. Current climate conditions drive extinctions in nearly every part of the world. Ecosystems thrive with biodiversity, though widespread extinction severely affects the state of biodiversity everywhere, which in turn damages ecosystems (Millenium Ecosystems Assessment Board, 2005).

The overwhelming majority of recent extinctions and biodiversity loss are due to anthropogenic activity. The principal causes are the destruction of habitats due to anthropogenic sea and land use, the exploitation of wildlife (hunting, farming, etc.), and damaging impacts on ecosystems because of invasive species, pollution, and climate change (Johnson, 2023). These

factors combined lead to a rise in the frequency and magnitude of extreme weather events that further cause biodiversity loss. There are also secondary causes of extinction that exacerbate these rates. When populations of species decline or are geographically restricted due to the degradation of their environment, they become further threatened because there is less to aid in recovery from this “loss of abundance” (Johnson, 2023). Another secondary cause involves species interactions within ecosystems. When a particular species sees a population decline or goes extinct, this will inevitably affect the populations of other species that are interacted with. Some populations may grow due to the loss of a predator. In contrast, others may decline as a result of the loss of prey, a species that it is interdependent on, or if there exists a mutualistic relationship. Anthropogenic impact on the environment not only causes the direct extinction of species but also leads to a chain of extinctions because of the nature of symbiosis within the natural world. The interconnectedness of ecosystems relies on stability and the interdependence that exists within species interactions. Disturbances in these natural structures result in detrimental impacts on biodiversity and lead to rising extinction rates.

Climate change driven by greenhouse gas emissions is dominant in Anthropogenic environmental change. Key greenhouse gasses include carbon dioxide, methane, and nitrous oxide, which are now more abundant than at any time in the past 800,000 years of Earth’s history (EPA, 2024). Since 1750, atmospheric carbon dioxide levels have risen by almost 50% (NASA, 2024). Methane levels have risen up to 2.5 times compared to levels in the 18th century (EPA, 2024). Since the beginning of the Industrial Revolution, nitrous oxide levels have risen by about 20% (EPA, 2024). These greenhouse gasses saw the most of their increase during the 20th century, aligning with the rise of industrial processes and production. As shown throughout history, extinction rates are significantly positively correlated with global temperature change,

while the main driver of global temperature change is greenhouse gas emissions (Song et al., 2021). Global warming, both atmospheric and in the ocean, is incredibly detrimental to species populations, as rapid changes in temperature lead to unstable climatic conditions that cannot support life as it was pre-industrial revolution.

Global Extinction Rates and Causes. To understand the issue at hand, one must look at the rate at which species are currently going extinct. The *natural extinction rate*, or *background extinction rate*, is the base rate of extinction throughout Earth's geological history. This statistic is essential to evolutionary models and permits species to change with time. The background extinction rate is about 1:1,000,000 species/year (including all living organisms), often used as a comparison for current rates of extinction (Pimm, 2023). It is also essential to factor in the fact that there is not an exact figure for the amount of species known to exist on Earth. Many organisms live in ecosystems that are, as of now, inaccessible to humans. Thus, documenting the current extinction rate becomes difficult because of the barriers to researching most species and their extinction rates. Therefore, this paper will use estimations to provide well-rounded rates of extinction. Estimates state that the current extinction rate is between 0.01% and .1% of species (WWF, 2020). This makes the estimate 100-1,000:1,000,000, compared to the background rate of 1:1,000,000. The United Nations 2023 Sustainable Development Goals Report estimates that the current extinction rate is tens to hundreds of times higher than the historical background extinction rate (UN SDG, 2023), while the Royal Society states "Our best estimates suggest that extinction rates in the recent past have been running 100 or more times faster than in pre-human times" (Foster et al., 2023). The current extinction rates are astonishingly high compared to the base extinction rate, creating a basis for a current extinction event.

Other essential factors that must be kept in mind when thinking about the uninhabitability of the Earth are how many species are at *risk* of extinction, the declining populations of existing species, and biodiversity loss. According to the UN 2023 SDG Report, up to 1 of 8 million estimated plant and animal species (including insects) are threatened by extinction within the coming decades (UN SDG, 2019). This report also states that there has been a 47% decrease in "global indicators of ecosystem extent and condition against their estimated natural baselines, with many continuing to decline by at least 4% per decade." (UN SDG, 2019) In terms of marine life, however, a study published by Nature Climate Change journal stated that almost 90% of marine life will be at risk of extinction by 2100 due to the current greenhouse gas emissions (Boyce et al., 2022). This risk of extinction is further exacerbated by the declining populations of species not yet extinct. According to the World Wildlife Fund's Living Planet Report 2022, there has been a 69% drop in wildlife populations and an 83% drop in freshwater populations since 1970 (WWF, 2022). Biodiversity loss is also crucial in gaining perspective on the habitability of the current state of the world. The world is seeing a swift decline in biodiversity, with Latin America and the Caribbean being affected the most with a 94% loss in biodiversity. Furthermore, Africa sees a 66% loss, the Asian Pacific at 55%, and other regions at 18% or higher (between 1970 and 2018). These percentages are on a rising trend, and there is no sign of them leveling out in the current decade due to unsustainable practices by humanity.

The exact percentage of species that go extinct in order to be defined as a mass extinction is commonly set at 75% of species that are extinct. This 75% of species must go extinct within a relatively short period of time on a geological scale. This time period may last a few thousand years to a few million years. If the sixth mass extinction is defined by the Anthropocene, it would have begun in the early 17th century (elaborated in ch. 2), making the time passed so far

~400 years. Compared to the five past mass extinctions, extinction rates today are higher, as more animals are going extinct in a far shorter period of time. The current extinction rate is 10 to 100 times higher than past mass extinctions, making the Anthropocene a new kind of extinction event that is more intense than observed before (Lau, 2019).

Projected Future Rates of Extinction. There are multiple reasons to expect an increase in extinction rates. The first is that current threats to species populations signal not only the future extinction of endangered species but also those that interact with these species (Johnson, 2023). The second is that Anthropogenic alterations to the environment are expected to increase and affect species' well-being in the long term (Johnson, 2023). Since 1880, the global temperature has risen about 2°F. Since 1981, it has increased by about .32°F per decade (Lindsey et al., 2018). 2023 was the hottest year on record, and there is a one in three chance that 2024 will be warmer (NOAA, 2023). The NOAA predicts that with emissions increasing at the same rate since 2000, the global temperature will rise at least 5 degrees Fahrenheit by the end of this century, above the average temperature from 1901-1960 (Lindsey et al., 2018). This is a high-speed rate of rising temperatures, and from these estimates, this rate will only continue to rise. Wildlife will not be able to migrate or adapt fast enough to survive on a planet so warm. A study by Haijun Song et al. published in *Nature* predicts that "a temperature increase of 5.2 °C above the pre-industrial level at present rates of increase would likely result in mass extinction," even excluding other anthropogenic environmental changes that are non-climatic (Song et al., 2021). Locations that are seeing the fastest and most severe increase in temperature are seeing the most regional extinctions (Román-Palacios, 2023). Species in these areas must be able to migrate to less warm environments, or they could be driven to extinction. It is estimated that with this current rate of global warming, ⅓ of plant and animal species could be driven to extinction

by 2070 (Román-Palacios, 2020). This study by Cristian Román-Palacios and John J. Wiens examined 538 species around the globe and determined that areas with hotter increases in annual temperatures see the most extinctions. Furthermore, this study examined higher extinction rates (~57–70%) when considering these species' ability to disperse from their habitat under changing climate conditions.

Global warming is not the only factor contributing to the current and future extinction rate. Deforestation is another essential aspect of the displacement and destruction of species and ecosystems that causes many species to go extinct yearly. Since the beginning of human civilization, about 15 billion trees have been cut down yearly, resulting in a 46% drop from the previous amount of trees (Ehrenberg, 2015). Due to deforestation, around 50,000 plant, animal, and insect species are extinct every year, while 157 plant, animal, and insect species are lost every day (World Animal Foundation). Agriculture and timber harvesting are the main reasons for such a loss in forest coverage worldwide. It is estimated that by 2050, the amount of tropical rainforests the size of India could disappear with the current rate of deforestation. Many species that depend on these ecosystems provided by tropical rainforests will be displaced, while others will simply vanish.

The IUCN Red List of Threatened Species states that there are more than 42,100 species threatened with extinction (41% of amphibians, 37% of sharks and rays, 36% of reef-building corals, 34% of conifers, 27% of mammals and 13% of birds) (IUCN, 2023). With this incredibly high number of species currently at risk of extinction, an extraordinarily high percentage of species can and will be lost in the coming years with humanity's impacts on the Earth. The UN SDG Report 2019 estimates that 30-50% of all species will face extinction by 2050 (UN SDG, 2019). Because the ecological state of ecosystems depends on a diverse system of animals at

various trophic levels, a 50% loss in species will only lead to more loss. With these estimates and the lack of progress humanity has made toward a sustainable functioning society, most wildlife will be unable to tolerate extreme anthropogenic environmental changes.

The key to estimating extinction rates in the future is to incorporate *co-extinctions* when species go extinct because of the loss of another species that it is interconnected with, into these predictions, as nature is inherently symbiotic and interdependent. A study by Giovanna Strona and Corey J. A. Bradshaw examines interconnected species loss on a planetary scale, projecting an unavoidable loss of 10% of species (of animals and plants) by 2050 and 27% by 2100 (Strona & Bradshaw, 2022). They further estimate that coextinctions will worsen the impact of primary extinctions by 184.2%. These projections are based on a scenario in which humans produce emissions on an intermediate scale, and it is important to acknowledge the unpredictableness of future carbon emissions, as they have the potential to both rise and fall depending on the effectiveness of global agreements and treaties, as discussed later in Chapter 4. Erosion due to species loss in ecosystem networks further removes resilience from species and their communities, as shown through these projections. Climate change is observed in this scenario as the dominant factor contributing to species loss. Though land-use change, co-extinctions, and biological invasions are also incredibly impactful, especially considering that co-extinctions intensify extinction rates significantly in this model (Strona & Bradshaw, 2022).

Considering the conditions of the Anthropocene today and the fact that one-third of species are threatened with extinction, there is no doubt that this number will continue to rise and the Earth will become even more uninhabitable. Habitat loss, terraforming/ecosystem changes, the exploitation of wildlife, the introduction of invasive species, pollution, and the spread of diseases and pathogens place further stressors on species populations. Because conditions are

changing for the worse so fast, species may not have enough time to adapt or migrate from their once healthy ecosystems to somewhere else that is suitable to them, and more and more species may be lost.

What is Happening in Haiti? Today, many disadvantaged areas are affected by climate change the most and are experiencing high extinction rates. As stated above, Latin America and the Caribbean are impacted the most, with a 94% loss in biodiversity between 1970 and 2018. The Caribbean islands, though very small in land area, account for >10% of known bird extinctions, >40% of mammal extinctions, and >60% of reptile extinctions since 1500 (Fauna & Flora, 2023). These once vibrant, incredibly biodiverse islands are seeing widespread regional extinction due to a past of colonization, improper agriculture, warming, and other factors. Additionally, sea level increases are exceptional in this region, and temperatures are rising. This paper will focus on Haiti specifically, a country that is under both social and natural threats. Haiti finds itself on the island of Hispaniola, neighboring the Dominican Republic. Although its land area is much smaller than that of the Dominican Republic, Haiti's population is higher, making it a very population-dense nation. Furthermore, Haiti sees much less rainfall, more rapid deforestation, and low soil fertility despite its history of agriculture. French colonists placed farms in places that were not fit for agriculture while using Haiti's forests for timber harvesting, causing the country's once 60% forest coverage to now be 1% (Diamond, 2011). To add to the many environmental problems of Haiti, this massive deforestation leads to flooding, and the topsoil becomes disturbed. There have also been exceptional natural disasters in this region that are incredibly destructive to both the people and the environment, such as the floods of 2004 and the 2008 hurricanes. It is estimated that between the years 1986 and 2035, 66–83% of species in Haiti will be extinct due to these problems mentioned above (Hedges et. al, 2018). Haiti will be

discussed throughout this paper to provide an image of how climate change and environmental irresponsibility, mostly through colonization in this case, can truly affect people and their surrounding ecosystems.

The combination of destructive methods of agriculture and other economic means, combined with the high population density and general instability of Haiti, means that this country is in dire need of humanitarian and conservation aid. 60% of citizens are under the poverty line and over half of the population is undernourished, signaling an alarming level of food insecurity (Staub et al., 2020). The quality of life is very low, with many people working on non-functional farms. Because of Haiti's vulnerability to the effects of climate change and the country's potentiality of regional extinction, there is also a vulnerability to health effects due to these natural changes. There are currently increases in vector-borne, water-borne, and heat-related diseases, severely impacting Haitians on the level of public health (Diouf et al., 2024). The increase in these diseases and illnesses can be traced to temperature rises and the decline in rainfall. Haiti's agrarian society has also been significantly impacted by species loss and climate change. Around half of the population of Haiti lives in rural areas, with agricultural production as a primary source of income. These farms are often small and rely on rainwater for irrigation. Considering the effects of rapid climate change, extreme weather events, and the impacts of species loss on the fertility of Haiti's land and rainfall, much of Haiti's population is impacted significantly today by the extinction rates. For example, in 2016, Hurricane Matthew destroyed 90% of crops in the Southern Plateau of Haiti. Not only does this damage Haiti's agricultural economy (which accounts for 22% of the nation's gross domestic product), but it also impacts the daily sustenance of Haitians, as well as their safety and security (including food

security and vulnerability to extreme weather events) (Staub et al., 2020). Thus, Haiti is experiencing instability both environmentally and socially.

Chapter 2: Histories of Extinction

The second chapter will use a historical lens to contextualize the Anthropogenic mass extinction with Earth's history. First, the "big five" extinctions will be examined and placed in relation to the Anthropocene conditions and extinction rates. Each of the 5 past mass extinctions will be reviewed with their causes, extinction rates and magnitudes, and recoveries. Then, the history of the Anthropocene will be discussed to understand the erasure of the Holocene, the magnitude of extinction, and the acceleration of climate change. Past civilizations' collapses will be considered, along with the conditions of the environments and how and why they collapsed. Finally, Haiti's environment and social history will be discussed to understand its conditions today.

The Causes and Aftermaths of Past Mass Extinctions. Mass extinctions are responsible for only 5% of all extinctions throughout Earth's history. Though they substantially impact the development and changes in biodiversity, as they encourage evolution through adaptation (Erwin, 2001). The primary causes of mass extinction are either rapid climate change or catastrophic events. Both of these factors lead to sudden extreme changes in environmental conditions that most species survive; therefore, a majority of species (>%75) are driven to extinction during these events (Rackj, 2019). Mass extinctions are defined by two factors: *magnitude* and *rate*. Magnitude is the number of species that see extinction, while the rate is how fast these extinctions occur. If both of these factors are high, as in >%75 of species extinct (magnitude) in a short geological period of time (rate), then this period of time is considered a mass extinction event. Rapid changes in atmospheric makeup, sea levels, global temperature, and

more are the leading causes of Earth's past mass extinctions. The first section of this chapter will examine these events, looking into their causes and effects to understand the similarities and differences to the Anthropocene and to provide a basis for speculation.

End-Ordovician extinction. This extinction occurred about 443.8 million years ago, the first known mass extinction. It ended the Ordovician period, where a significant increase in marine and plant life occurred. Silicate weathering is thought to be the cause of this event, a phenomenon in which silicate minerals (minerals that store carbon found in the Earth's crust) store enough carbon to cause the global temperature to become cooler. However once there was enough ice to cover silicates, the carbon returned to the atmosphere, reversing the previous effects and causing rapid fluctuations in sea levels and global temperature. Thus, many species, specifically marine species, could not survive due to these rapid changes. It is estimated that 86% of species were lost during this extinction event (Bond et al., 2020). Concerning recovery, species immigration was crucial in restoring biodiversity to its pre-extinction levels. Within 5 million years, marine diversity recovered (Krug et al., 2004). This results from species immigration, as species that survived found environments that suit their survival needs, leading to evolution (Krug et al., 2004).

End Devonian Extinction. Although the magnitude of species loss during the End Devonian Extinction was high at ~70-80% of species, the extinction rate was relatively low compared to other mass extinctions. This mass extinction was so destructive because of the low speciation – evolution was happening very slowly. The driving transformer of the environment during this time is ocean anoxia, a depletion of oxygen in Earth's oceans, making it unsuitable for marine species to continue to survive. Ocean anoxia, which occurred alongside stagnation, was primarily caused by tectonic activity, fluctuations in sea levels, extraterrestrial impact, and

volcanism (Barash, 2017). After this mass extinction, current research suggests that diversification took about 10 million years to reach pre-extinction levels. It is thought that a delay in the "reestablishment of ecological communities" caused this recovery time (Erwin, 2001).

End Permian Extinction. The End Permian mass extinction involves the greatest biodiversity loss of all other mass extinction events, in which 95% of species are thought to have gone extinct. The cause of this high magnitude of extinction is not precisely known. However, a recent study published in Science Advances states that there were two phases of high carbon emissions, the second causing rising temperatures and ocean acidification (Yuyang et al., 2023). It is estimated that about 80% of marine and 70% of terrestrial species went extinct during this period (Yuyand et al., 2023). Concerning recovery, some individual species started to reappear rapidly, though the reappearance of biodiverse ecosystems required about 5 million years (Bowring et al., 1999). Following this extinction came a burst in reptilian evolution, as dinosaurs and ancestors of modern-day reptiles first appeared.

End Triassic Extinction. The End Triassic extinction was also caused by widespread volcanic activity increasing the global temperature due to greenhouse gas emissions. This rise in temperature caused sea levels to rise and other climate changes, while the carbon cycle was disturbed and ocean acidification occurred (Chu, 2013). This resulted in losing about 76% of marine and terrestrial species (Chu, 2013). Following this event, about 135 million years later, dinosaurs became dominant on land during the process of recovery and evolution. However, immediately following the extinction, the Earth was left with little biodiversity for about 10 million years.

End Cretaceous Extinction. The End Cretaceous extinction is the most well-known mass extinction, responsible for the disappearance of all non-avian dinosaur species. The consensus concerning the cause of this mass extinction is that an asteroid made an impact on what is now known as the Yucatan Peninsula in Mexico. It is thought that when this asteroid struck Earth, it blocked sunlight while sending waves of heat and soot worldwide (Chiarenza et al., 2020). This caused 76% of species to go extinct due to the lack of sunlight and fast environmental changes. With all dinosaurs extinct, excluding birds, mammals and bird species were able to gain dominance on land. For terrestrial species, biodiversity did not return for about 5 million years, though marine species biodiversity returned to pre-extinction levels in about 3 million years, a timeline similar to the End-Permian extinction (Bowring & Erwin, 1999).

History of the Anthropocene. As described previously, the Anthropocene encompasses an epoch of rapid climate change and extinction. The origins of these changes are global and have affected every corner of the Earth. Colonization, globalization, industrialization, capitalism, and many more economic and social developments following the Orbis Spike of 1610 are key characteristics of this time. The Anthropocene marks centuries of destruction, both social and environmental. Paul Crutzen initially coined the term to describe an epoch in which humanity impacts the environment in various ways, showing force over natural processes and manufacturing hazardous chemicals (Crutzen, 2006). In his chapter in *Earth System Science in the Anthropocene*, Crutzen elaborates on his original coining of the term and suggests the date proposal of 1784, which coincides with the invention of the steam engine, with the industrial revolution following (Crutzen, 2006). The year 1784 shows global CO2 emissions of 17.47 million tonnes globally, compared to 1750, which shows global CO2 emissions at 9.31 tonnes with a steady rise in between (Ritchie & Roser, 2024). There have been numerous other

proposals concerning dating the Anthropocene, a decision that will impact both scientific and social circles. Simon Lewis and Mark Maslin published *Defining the Anthropocene* in 2015, in which they discuss evidence for various proposals, including the first uses of fire in the Pleistocene, the agricultural revolution, the colonization of the Americas, the Industrial Revolution, and the Great Acceleration (Lewis & Maslin, 2015). To provide backing evidence for a date proposal, geological evidence must be found in sedimentary forms showing a global strata marker or a Golden Spike. Lewis and Maslin conclude that the Great Acceleration (1964 – CO2 emissions of 10.82 billion tonnes (Ritchie & Roser, 2024)) and the colonization of the Americas (1610 Orbis Spike – atmospheric drop in CO2 levels partially because of the depopulation of indigenous Americans (Koch et al., 2019)) both show global markers that demonstrate global changes in climate for the two specific dates (Lewis & Maslin, 2015). They conclude that the 1610 Orbis Spike is the most viable date with a GSSP marker that represents both the geographical and historical significance of this event, and it demonstrates changes in "climate, chemistry, and palaeontological signals" (Lewis & Maslin, 2015, 177). The Anthropocene Working Group (AWG) has since proposed the date in the mid-20th century, coinciding with the Great Acceleration due to a viable GSSP marker that shows a global spread of artificial radionuclides in the early 1950s. This Golden Spike is a primary marker, and following this event is what the AWG considers to be the Anthropocene.

For the purpose of this thesis, the start date for the Anthropocene of the 1610 Orbis Spike will be used because it represents the beginnings of worldly ecological change as well as economic and social structures that negatively affect humans and other species, both found in global stratigraphic sediments (Lewis & Maslin, 2015). This Orbis Spike coincides with the colonization of the Americas. At the same time, 1610 shows a global drop in CO2 in sedimentary

layers, as well as evidence of widespread ecological change due to the Columbian Exchange (Davis & Todd, 2017). After this event, environmental degradation resulting in species loss only continued to be exacerbated through the effects of colonization, leading to industrialized capitalism. The Columbian Exchange, which was exaggerated following 1610, included transferring enslaved people, plants, animals, diseases, and more between continents. The plants and animals exchanged for economic growth provided the means for European methods of agriculture to travel elsewhere, using crops and livestock from all over the world (Lewis and Maslin, 2015). Furthermore, extracting resources from colonized regions was also a means for economic growth and power while changing landscapes through terraforming severely altered environments (Davis & Todd, 2017). This period of time, during and shortly after the Orbis Spike of 1610, represents the beginnings of a series of rapid climate and environmental changes that also had detrimental effects on marginalized communities, especially Indigenous Americans and enslaved Africans.

These means of economic growth through colonization eventually provided the basis for industrialized capitalism in the 18th century and later the great acceleration in the 20th century. The land of the "new world" was used for the extraction of natural resources, agriculture, and labor from enslaved people. To continue accumulating capital, many technological advancements occurred, which made it possible to spend less to achieve a higher value for a commodity. An example of technological advancement would be the steamboat – a faster means of transportation. It required a continual source of coal to operate, thus requiring more natural resources. This is, following the invention of the steamboat in 1784, precisely when greenhouse gas emissions are shown in atmospheric concentrations (Crutzen & Stoermer, 2000). This shows an intensification of global impact in stratigraphic sediment, acting as a global continuation of

anthropogenic environmental impact following 1610. Following the invention of the steamboat came technological and industrial developments (e.g., textile factories, locomotives, dynamite), which required the exploitation of colonized land, resources, and people. The industrialization of the Americas had worldly consequences, as new methods of production required the use of coal, then oil, marking the beginning of humanity's remarkable greenhouse gas emissions. In the 19th century, extinction rates began to rise above the base extinction rate due to GHG emissions, land use, pollution, degradation, hunting, and more anthropogenic activities (Ceballos et al., 2015).

Following the Industrial Revolution came the Great Acceleration, which encompassed a period of a globalized, capitalist society. The production of commodities transformed by the mid-20th century, allowing many products to be produced incredibly fast with little cost due to advanced machinery and cheap labor from underdeveloped countries. Emissions and extraction continue to rise in the 21st century while the climate continues to change rapidly. During the past half-century, most of the global temperature rise occurred (NASA, 2024). This period of time, specifically the summer of 1988, is when the issue of global warming due to GHG emissions finally arose in the public eye. This particular summer was the hottest on record, though, after 1988, countless hotter summers have followed. James Hansen, at the time the leading climate scientist of NASA, along with other senior researchers, warned the world that the rising temperature was almost absolutely a result of human activity to the U.S. Congress (Butler, 2018). This testimony had an unprecedented backlash, and Hansen was heavily criticized. Corporations and others in power invested incredible amounts of money in lobbying to prevent energy transition. Environmental activist groups arose during this time to spread information and politicize the urgency of global warming (Weart, 2012). Scientists increased research to understand what exactly was causing the temperature to rise so severely – some thought the sun's

activity was increasing. Others thought computer models showing the rise in global temperature were flawed (Weart, 2012). It was then thought that, eventually, the world would see widespread malnutrition, war over scarce natural resources, refugee crises, high precipitation, rising sea levels, etc., as the climate would continue to change. The increase in public knowledge in 1988 surrounding climate change is a fundamental benchmark in the Anthropocene, as it shows the exemplary polarization of humanity.

The Intergovernmental Panel on Climate Change (IPCC) was created in 1988 in the wake of this increase in public knowledge and Hansen's testimony by the World Meteorological Organization (WMO) and UNEP (IPCC Archive, 2021). The UN General Assembly Resolution outlines the IPCC's original task, which was to: "prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; the social and economic impact of climate change, and possible response strategies and elements for inclusion in a possible future international convention on climate." (IPCC Archive, 2021) Today, the IPCC continues to prepare reports assessing the state of scientific, public, and governmental knowledge of climate change and climate-related social issues. The goal is to provide reports and assessments that are transparent and widely available that concern the changes in climate and adaptation/mitigation efforts and the success of these efforts. The IPCC also aims to be neutral and objective concerning policy while bringing attention to technical and socio-economic factors that are impacted by climate change and climate-related policy (IPCC Archive, 2021). The creation of the IPCC and its continuation is important because the Anthropocene continues to this day, and there continue to be many debates concerning the severity of humanity's impact on the planet. Although there is further debate about whether or not the Great Acceleration

continues, humanity remains the driving factor behind global environmental change, and the Anthropocene represents the period of these environmental changes.

The Fall of Past Civilizations. Before humanity globally transformed the natural world, regional extinctions due to environmental degradation occurred, leading to the collapse of ancient societies. Perhaps one of the most known is the Rapa Nui of Easter Island, an island once covered with trees and bushes, now barren and desolate. Species of palm trees, birds, lizards, insects, and more were lost due to human impact on this island. The root of this regional extinction is deforestation; once the palm trees, which were native to the island, went extinct, many species lost their habitats, leading to others losing their food source. The cycle continued until the island was essentially empty of life. It is thought that the reason Easter Island palm went extinct is overharvesting and its use to transport the Moai rock sculptures from place to place. The population of Rapa Nui continued to grow from the 12th century to the 17th. Once the island was depleted of its palm trees, war, famine, and the Rapa Nui culture collapsed, leading virtually every inhabitant of Easter Island to disappear (Hunt, 2019). Easter Island is an example of a society that, knowingly or not, degraded its environment to the point where it could no longer support humanity and the other species on that island, leading to a civilization collapse riddled with devastation, anger, and loss. The regional extinction of Easter Island has only anthropogenic causes: deforestation, overpopulation, and extraction of natural resources.

The collapse of Eastern Mediterranean civilizations in the Late Bronze Age led to many questions about what caused the collapse of so many advanced, interconnected, and stable societies. Eric H. Cline suggests in *1177 B.C. The Year Civilization Collapsed* that around 1177 B.C., multiple interconnected factors contributed to the decline of the civilizations in the Eastern Mediterranean, such as climate change, disease, invasion, migration, and economic and political

instability (Cline, 2021). One reason to suspect climate change is the evidence of migration due to a drought that is believed to have hit the region at about 1200 B.C. It is thought that about 120,000 people migrated from this region in the form of "push-pull" migration as a result of possible drought, crisis, overexploitation of the land, and limited resources, as is shown through pollen analysis (Cline, 2021, 153). Another likely factor that contributed to the collapse of this region is famine, which can be inferred through letters sent throughout the region. Cline discusses the Hittites requesting what would today be considered aid from the Egyptians. The land of the Hittites in Anatolia, and possibly even Uragit, requested grain from other societies, leading many to believe that there was not only a catastrophic famine in Anatolia but also spread to other regions. As is evident from archeological findings and the letters discussed, there was an environmental emergency in the whole of the Eastern Mediterranean region from the 13th to the 12th century BCE. At the same time, these climatic cataclysms further lead to social and political unrest in the fight for land and resources between these societies (Cline, 2021, 155). This famine would have resulted from the drought, causing agricultural production to be insufficient, while it is thought that this period could have been the driest period this region has experienced.

Though there is not a solid consensus as to what caused this drought, it is thought that volcanic eruptions from Mount Etna in Sicily could have caused it. In contrast, others believe an eruption from Thera/Santorini led to the climatic changes (Cline, 2021, 163). Cline lists other theories regarding the cause of the drought, such as a "'solar minimum,'" an increase in "'ice-rafted debris'" in the North Atlantic, or cold spells from sea surface drops creating rapid climate changes (Cline, 2021, 163). However, what is clear is that a sudden change in climate conditions led to widespread persisting drought, which placed stressors on other existing issues. This may have sparked rapid collapse, especially during a megadrought, as a drought that

prevails for hundreds of years does not allow societies to recover to their original state. Cline suggests that during the Late Bronze Age, there occurred a combination of an exacerbation of stressors from the megadrought with a "'domino effect,'" which refers to a system falling as a result of a singular failure leading to many failures thereafter (Cline, 2021, 165). Thus, environmental stressors combined with social and political issues in the eastern Mediterranean led to the collapse of many interconnected civilizations because these societies were overwhelmed by the many different stressors (Cline, 2021, 166). What is revealed by the collapse of these interconnected civilizations is that climate stability is crucial to the health of human society. Not only does drought and the depletion of water and crops lead to civil and governmental issues, but it also exacerbates other underlying issues that can lead to detrimental consequences, as it did in the case of the eastern Mediterranean during the 12th century BCE.

An Environmental History of Haiti. Haiti's history of colonization has greatly affected the vast mountainous and forested ecosystems found on the island of Hispaniola. Before the arrival of Columbus in the West, this region had been inhabited by indigenous groups, making a population of about half a million, having been there for about 5,000 years. After the arrival of the Spanish, Indigenous Hispaniolans were enslaved and infected with Eurasian diseases, significantly decreasing the population to about 3,000 people (Diamond, 2011, 334). About a quarter of a century later, sugar plantations owned by Spaniards and worked by enslaved Africans led the colony to grow economically up until the 16th century, when Spain set their focus to mainland Mexico. Soon after French colonists took over all of Hispaniola, a rebellion from the enslaved people of Saint-Domingue forced France to leave the island. During this rebellion, enslaved Hispaniolans destroyed the former plantations to ensure it would be impossible for the slave system to return. This resulted in Haiti's agricultural productivity never

returning to its previous state, damaging its economy and export status for good, along with other substantial factors such as climate conditions (Diamond, 2011, 335). It is estimated that due to European colonization, Haiti lost 4.8% of its primary forest coverage at this point in its history (Hedges et al., 2018). Following colonization, Haiti was marked by its continuous state of political instability, with countless revolutions and assassinations of presidents. These political and economic factors are important in understanding how the ecology of Haiti became the way it is today and how it affects the island's people. Haiti has an arid climate compared to its neighboring Dominican Republic (Diamond, 2011, 336). Most mountain rain and water runoff flow eastward, leaving Haiti with less plant growth and thinner soil. Furthermore, Haiti is very mountainous, leaving less flat land fit for agriculture. While Haiti was under French and Spanish occupation, it developed economically due to agriculture, though it irreparably damaged the land because it was unfit for agriculture. During the French occupation, when France was sending enslaved Africans to Haiti to work on sugar plantations, the population grew 7 times higher. Thus, this high population, combined with thin and infertile soil, low rainfall, and inappropriate agriculture, led to much deforestation by the mid-19th century (Diamond, 2011, 339). This long, devastating history has led to Haiti's state today, as it is a poor country composed of small farm workers who have incredibly unfit land to work with. Colonization has caused these poor living conditions and environmental degradation throughout the country, having purely anthropogenic causes.

As stated in Chapter 1, Haiti today has a primary forest coverage of less than 1% of the original coverage. This is a result of the country's tumultuous environmental and social history. Forests, especially tropical forests, are responsible for much of global biodiversity, but because Haiti is one of the most deforested countries in the world, it is rapidly losing many species. It

shows trends toward regional mass extinction (Hedges et al., 2018). The threat of extinction in Haiti is specifically pertinent because of its rich populations of endemic species. 75% of its vertebrate species are only found in the region. Deforestation is the primary threat to species extinction in Haiti, as when endemic species lose their habitat, their populations drop, and there are no other organisms of that species in the world. Because only 8 of 50 of Haiti's mountains still have some primary forest remaining, Haiti is experiencing an extinction (Hedges et al., 2018). The extreme loss of forests leads to many species extinctions due to Haiti's once richness in endemic species. In contrast, this forest loss results from the country's history of agriculture and colonization. As climate change becomes more extreme, Haiti's vulnerability worsens. Some primary forests in Haiti are only lightly disturbed now and can continue to support, for the most part, the biodiversity they contain. This makes these forests vulnerable to climate change, as the forests are already weakened and cannot withstand extreme weather (Hedges et al., 2018). These forests in transitional periods, as they are mostly primary and contain high species richness, will lose this richness in the long term (Hedges et al., 2018).

The removal of Haiti's once rich and plentiful forests has led to many instances of catastrophe and extreme weather. These catastrophic events cause further destruction of crops, high temperatures, depletion of water sources, landslides, and increased vulnerability to hurricanes and earthquakes. Agricultural yields have already reduced significantly and are expected to continue to plummet as the forests disappear and weather disasters prevail (Montuma, 2023). The need for disaster relief has increased considerably within the past few decades, as incredibly destructive earthquakes and hurricanes pose detrimental threats to Haitians and their land. Over 96% of the population is exposed to extreme natural disasters, as most of the population lives on the coast due to the mountainous terrain (Climate Change Knowledge Portal,

2021). These catastrophic events have proven to be detrimental to the region's well-being. The earthquake of 2010 killed ~250,000 of the ~11 million population previously, resulting in a 120% loss in GDP. Hurricane Matthew, which occurred in 2016, increased GDP loss by 32% (Climate Change Knowledge Portal, 2021). Not only is the quality of life rapidly declining due to climate change and environmental degradation, but it is expected to continue declining because Haiti significantly lacks the resources to rebuild and reinforce its infrastructures and create proper and effective precautions for extreme weather and natural disasters.

Chapter 3: The Future of the Planet

This chapter will discuss speculation of future ecologies, species, societies, and imaginations of the future in fiction. First, this chapter will look at pieces of fiction that depict the future of the Earth in the context of climate change and use a sociological lens to examine these works. Then, the second section will use predictions based on science concerning speculative evolution and then look at the future of humanity in the next section. Finally, the future of Haiti's environment and people will be examined.

The Genre of Speculative Evolution/Evolutionary Biology. Speculative biology or evolution is an emerging subgenre of scientific fiction that provides predictions as to what species will look like in the future. *After Man: A Zoology of the Future* by Dougal Dixon essentially gave birth to this genre in 1981 while incorporating disciplines of evolutionary biology, paleontology, and ecology. This book is set 50 million years in the future on a planet where humans no longer exist. Various ecosystems, food webs, and more are pictured, demonstrating a planet completely different from what we know today, having adapted and changed from the current geological epoch onto the next. This piece of speculative evolution consists of imaginary species of the future, and it is instrumental in its depiction of evolutionary

patterns. Dixon acknowledges that providing completely accurate predictions concerning future evolutions is virtually impossible. Events such as sudden planetary catastrophes and mutations may have the ability to change entire ecosystems over time. Considering *After Man* was completed in 1981, it is also important to acknowledge that Dixon hadn't seen the full effects of climate change and the anthropogenic impact on evolution. However, he made it clear that humanity has had and will continue to have a negative impact on the environment. He states, discussing life on Earth until the end of its planetary life, "How life will evolve over that period there is no way of knowing, but there is one thing of which we can be sure, and that is that the animals and plants will not remain as they are." (Dixon, 1981, 112)

In Amitav Ghosh's *The Great Derangement,* various literary genres are analyzed in the context of climate change, including those that involve aspects or themes that are "uncanny," which express strangeness, unfamiliarity, and mysticalness. Before recent understandings of climate change, it was thought that changes in climate occur slowly rather than in jumps occurring and suddenly disturbing natural patterns. Ghosh states, "Climate change is inherently uncanny: Weather conditions, and the high-carbon lifestyles that are changing them, are extremely familiar and yet have now given a new menace and uncertainty," (Ghosh, 2017, 30). Dixon follows the common belief that natural changes happen over long periods. *After Man* shows an Earth 50 million years in the future, with species requiring time to evolve dramatically. Though what is being seen today, as species adapt and evolve due to anthropogenic climate change, is uncanny in the sense that these changes are happening incredibly fast, and these adaptations have a sense of strangeness.

In recent years, speculative fiction has also appeared on screen. 6 Degrees Could Change the World is a television documentary from National Geographic that shows the impacts of the

rise in global temperature. Degree by degree, this documentary highlights how severe and impactful a seemingly small temperature rise can be for the planet (Bowman, 2007). Not only does this film document speculative events and ecosystem responses to the warming of the Earth, but it also documents the impacts of the temperature rise today. It emphasizes that these effects have the potential to be exacerbated in the future. Notably, the 30,000 mortalities during Europe's 2003 heat wave show that the temperature rise alone is incredibly dangerous (Bowman, 2007). This documentary and work of speculation combines the effects of climate change today with potential changes in the future and raises questions, such as how current struggles from climate change, environmental degradation, and other anthropogenic impacts on the environment will be intensified in the future (Bowman, 2007). Conversely, *Life After People* from the History Channel shows, as is evident from the television series title, an Earth in the absence of humans in the near future on the geological time scale (Fallows, 2008). Images highlight structures created by humans overwhelmed by the surrounding ecosystems, examine possible struggles for different species and how their interactions may change, and speculate the fate of humanity's infrastructures, tools, and homes (Cohen, 2008). It is important to note that although speculation is impossible to prove until the moment arrives, these two visualizations utilize testimonies and research from biologists, geologists, botanists, archaeologists, and more, similarly to Dixon. Though *6 Degrees Could Change the World* and others alike may cause great anxiety for people today.

Concerning documentaries that focus specifically on speculative evolutionary biology, *The Future is Wild* is a work of speculative evolution in the docufiction medium (Fallows, 2002). Dixon aided in developing this series among other scientists in various fields. The series has since become incredibly popular and has become an entertainment franchise. 12 different

ecosystems worldwide are examined with speculated changes and outcomes 5, 100, and 200 million years in the future. The series suggests an ice age will arrive in 5 million years and describes changing continental formations, evolving species, and dry climates. In 100 million years, the series shows a world hotter than today, with marine species migrating to land, more severe continental movement, and higher ocean levels (Fallows, 2002). Finally, in 200 million years, the series speculates a mass extinction where 95% of species disappeared as a result of a flood basalt eruption and shows ecosystems recovering (Fallows, 2002). There is now a new supercontinent, or a super-Pangea, and fish fly, squids find themselves in dense forests, and other survivors of the extinction such as other fish, worms, insects, and more grow in population, enduring the extreme weather caused by the novel geographic setting (Fallows, 2002). Thus, the computer-generated images throughout this series provide audiences with a sense of how the species, environments, and land known today may change. These films and other works of speculative fiction provide audiences with an imaginative experience of what the Earth will look like in the future, a topic that catches the attention of many.

What Will Species Look Like in the Future? As explained previously, species must either migrate or adapt to survive the rapid changes to their habitats. One adaptation to climate change that has been observed among a variety of taxa is simply a speed-up in reproduction, thus causing evolution. Reproduction is key to evolution, as it allows offspring to obtain traits that are fitter to the organisms' environments, changing genetic codes and, over time, leading to the appearance of new species. Species have been observed to reproduce earlier in their lives when their ecosystems change. Therefore, when ecosystems change, species evolve in the form of evolutionary adaptation (Hoffman, 2011). These patterns are seen most often in species that have migrated to new ecosystems because their previous habitat was altered or destroyed

anthropogenically. They are also seen in species found in their native environments, though these environments have been changed due to the invasive species described previously. Those species that cannot migrate from their native environment must partake in evolutionary adaptation to ward off the threat of survival posed by invasive species. Invasions of foreign species further affect evolution through reproduction because these new species essentially change how genes are transferred within ecosystems while placing unfamiliar genotypes in native habitats during hybridization (Hoffman, 2011).

Evolution is therefore key to climate change adaptation. Those species that have low reproduction rates and an inability to migrate are much less likely to survive through changes to their native environments, while other adaptive species are seen to survive for longer amounts of time. Fast-lived species, or those with short life spans, are more likely to withstand alterations to their environment rather than slow-lived species as a result of the ability to adapt through evolution and reproduce faster by nature (Albaladejo‐Robles, 2022). Slow-lived species and larger organisms, such as mammals, are unlikely to survive because they cannot reproduce efficiently and because most mammals, especially large organisms, require a wide range of terrain to hunt, scavenge, and feed (Hetem, 2014). This will make it more likely that their environment will degrade anthropogenically as a result of the size required for them to maintain life. Larger organisms also require more food and water, while species with niche diets are further threatened due to decreased resources (Bryce, 2023). The survival of these species entails ecosystemic evolutions due to climatic changes, the introduction of novel species and genotypes, and the evolutionary changes taken on by the species themselves.

Climate change is not the only factor contributing to biodiversity loss and extinctions throughout the planet. Various Anthropogenic factors damage ecosystems and make evolutionary

adaptation and migration necessary for species, such as nuclear disasters, agriculture, suburban and urban sprawl, etc. Studies on bird and dog adaptations in Chornobyl are acute examples of anthropogenic environmental alterations that show taxa's ability to withstand external pressures through adaptation. A study by Ismael Galván et al. found that chronic exposure to low-dose radiation essentially favors adaptation to oxidative stress (caused by ionizing radiation) in 16 bird species examined in Chernobyl. They found that body condition increased while oxidative stress decreased among the bird species more highly exposed to ionizing radiation from the nuclear disaster (Galvàn et al., 2014). These birds also were found to have higher levels of antioxidants, which prevent and reduce damage caused by oxidants. Another study by Spatola et al. examines chronic exposure to low-dose radiation of dogs free-roaming within the powerplant itself and in Chernobyl City. Many of these dogs were formerly domestic and owned by the previous inhabitants of Chernobyl. They were infamously hunted down and killed to prevent the spread of radiation to other areas, though many of them survived and continue to live in the contaminated areas to this day. It was found through this study that these two groups of dogs are genetically distinct. Furthermore, those living in the power plant are genetically different from those living in Chernobyl City due to varying amounts of low-dose radiation, making the necessity to adapt to radiation different between the two groups (Spatola et al., 2023).

Anthropogenic climate change places incredible pressure on species to adapt. Sarah P. Otto provides a list of selection pressures provided by humanity, which provides a basis for speculating which species may survive in the future of the Anthropocene. The first pressure is "selection to survive in built landscapes." Species that can adapt and survive in urban and industrial places show incredible resilience to human activity and are taking advantage of the presence of populous areas. This includes specific species of birds, rats, mice, cockroaches,

mosquitos, and more. Those pests that invade cities are exceptionally adaptive and thrive under anthropogenic conditions. The second pressure is “selection to avoid hunting or harvesting.” Species have been found to adapt through evolution to avoid being hunted, as selection favors the traits most sought out by humans. Species that can do this successfully are likely to endure through the Anthropocene. The third pressure is “selection in novel communities.” Communities are affected at different rates by the introduction of invasive species and environmental alteration, while communities’ ranges also shift at different rates. Those that can survive in novel environments without niche requirements are most likely to survive. “Selection on dispersal” is the fourth pressure, highlighting that reduced dispersal in the short term improves overall species survival rates; it will be necessary in the long term as the climate changes. This is a result of the fact that there will be low speciation immediately preceding a mass extinction, and for new species to arrive, species must disperse into novel communities. Finally, the last pressure is “selection on inheritance systems.” Selection during times of rapid climate change historically favors increased mutation rates. This will allow species to change through reproduction while offspring inherits favorable mutations in the changing environment. These selection pressures further demonstrate the desired traits for species to continue to survive in a changing environment. These pressures become a form of selection that is not completely natural because organisms have to adapt to conditions placed upon the Earth by humans rather than natural climatic processes (Otto, 2018).

Some species are in fact thriving under the current conditions of the Anthropocene. Some believe that speciation may rise due to hybridization due to the introduction of novel species (Thomas, 2013). Cephalopods are an example of a growing species, as their populations have been observed to increase contrary to previous assumptions. The reason for this increase is

unknown, as it could result from hunting their predators or warmer oceans favoring this group (Baraniuk, 2022). The consensus is that species that are low on the food chain and small are likely to survive. Rodents and insects are both small and find themselves on low trophic levels. Furthermore, they do not have niche diets, are highly adaptive, and have thus far coped well during the Anthropocene (Bryce, 2023). It is not thought that large mammals will continue to be the dominant group in the event of a sixth mass extinction because of the extensive habitat required and the slow-lived nature of these groups of animals. On the other hand, small rodents, specifically rats, thrive when *defaunation*, or the extinction of animal species, occurs (Dirzo et al., 2014). Massive increases in rodents have been observed in areas that have seen defaunation. The conditions of these ecosystems change as the grass and shrubs that would have been previously consumed by larger mammals grow, providing shelter and food for the rodents. Furthermore, rodents carry a variety of diseases and pathogens (through ectoparasites) that are deadly and dangerous for humans and other species in the areas where rodent populations grow (Dirzo et al., 2014).

Dr. Jan Zalasiewicz, a paleontologist and geologist at the University of Leicester, suggests that rats, specifically, have the potential to fill the spaces in ecosystems that larger mammals once occupied. Over tens of millions of years following a potential anthropogenic mass extinction, Dr. Jan Zalasiewicz believes that rats could even evolve to be larger while filling these lost niches (potentially as large as a capybara, Earth's largest rodent) (Marriott, 2014). This speculation depends on the criteria for what exactly counts as a 'dominant' species and the fact that there is no viable way to make exact predictions for how the Earth will change. Rats may have the potential to become a dominant species in a similar vein to humans during the Holocene and the Anthropocene. Avolio et al. define dominant species in their paper

Demystifying Dominant Species: “species that have high abundance relative to other species in a community and have proportionate effects on environmental conditions, community diversity and/or ecosystem function.” (Aviolo et al., 2019) Thus, humans are not the only dominant species on Earth. Although the human species is the main driver in climate change, environmental degradation, and other environmental alterations, many other species are abundant, essential to ecosystem functions, and impact their surrounding environments. In the absence of humanity and species that are key to ecosystem functioning, changes in ecosystem evolution will occur.

Societies, Infrastructures, and More in a Changing Environment. With incredible loss concerning the natural world, humanity is already seeing the effects on its well-being from anthropogenic climate change and environmental degradation. These effects will only be exacerbated as extinction rates continue to rise. Geopolitical crises are expected to increase significantly as natural resources continue to be depleted with improper regulation. This may lead to territorial conflict and war, as seen today. Refugee crises are also expected to rise while catastrophic events, natural disasters, rising sea levels and temperatures, and more worsen with the changing climate. The horrors of the Anthropocene, with the continuation of exploitation of both land and people, will continue to be exacerbated in the event of a mass extinction, as a changing climate seeing less and less biodiversity will lead to an Earth unfit for current human activity.

Diverse and healthy ecosystems are important to health and act as barriers from illnesses. Incredibly niche plants and fungi that are rapidly disappearing are used as medicine. Furthermore, nature often acts as a buffer between humans and various diseases and viruses. For example, areas with high diversity in bird populations have shown fewer cases of the West Nile

virus (Swaddle et al., 2008). It has recently been demonstrated that high biodiversity rates prevent the transference of pathogens because different species take over different habitat areas, leading to reduced contact rates (Ramanujan, 2014). Though when the habitats of these species are diminished, and they must migrate in order to survive, they then make contact with other species and transfer pathogens, eventually reaching humans while negatively impacting the populations of those species who are now at risk of contracting this pathogen (Ramanujan, 2014). Thus, with predicted extinction rates and biodiversity loss for the coming decades and centuries, humans will be more likely to experience these wild pathogens, and these diseases may spread.

Humanity has become dependent on agriculture over the past 10,000 years, and, more recently, industrial agriculture. Agriculture was an essential benchmark in creating the complex societies and civilizations seen today, as it allowed humans to no longer need to hunt and gather food, making it possible to settle and stay in one place as a society. Humanity could, preceding the agricultural revolution, focus on the higher levels of the hierarchy of needs with a constant, reliable source of food. However, this scale of agriculture is possible because the Holocene provided the Earth with a stable climate that allowed crops to grow at certain times of the year (Feynman, 2019). By 2100, the global temperature is expected to rise to a point where the climate will no longer be stable enough for agriculture, returning to conditions similar to the Pleistocene, when agriculture was impossible (Gowdy, 2020). Thus, it has been theorized that it will be necessary for humanity to then return to the hunter-gatherer methods of the Pleistocene. On the other hand, food insecurity and prices could rise as agriculture becomes unproductive. Though different methods of agriculture have emerged during the past few decades, such as vertical/indoor farms, aquaponics, etc.

Including negative impacts on agriculture, food security, and disease, there are a variety of other negative effects on humanity that result from climate change. To start, changing temperatures and unstable climates lead to severe weather. In recent years, hurricanes have become more powerful and contain more precipitation because of rising temperatures (NOAA, 2021). Droughts may also become more common, as current trends of precipitation show in some regions, which not only depletes water resources but also causes more instances of wildfires (NOAA, 2021). Flooding and other natural disasters present serious safety risks to many communities, while hotter summers can lead to deadly conditions. These impacts of climate change also create new challenges for existing infrastructure that is not built to be resilient to the changing climate. First, as temperatures rise and change, heating and cooling systems may be used more frequently, thus stressing the energy grid. Homes, roads, bridges, facilities, and more structures in coastal zones are likely to be impacted by severe weather patterns, while these infrastructures were likely not made to be sufficiently resilient. In general, the effects of severe weather and natural disasters may be detrimental to the infrastructure that is used by humanity daily, as climate change places stressors on them that they may not be able to stand, especially in vulnerable regions (NOAA, 2021).

Future Effects of Climate Change in Haiti. Considering Haiti's current trend of deforestation since 1986, it is projected that all primary forests in Haiti will be lost by around 2035 (Hedges et al., 2018). This loss will remove the habitat of various species, as is seen today, with less than 1% of forests being lost. It is estimated that about 66-83% of species will go extinct between the period of 1986 and 2035 in this particular region. Depending on how many species are able to adapt or migrate to the future conditions of Haiti, this region will undergo a regional extinction event in the next few decades and is currently in the process (Hedges et al.,

2018). As the once vastly forested mountains lose their primary forest, the soil often quickly becomes barren and infertile (Hedges et al., 2018). This exacerbates further the inadequacy of Haiti's climate and environment for agriculture. As mentioned in previous chapters, the threat of natural disasters and catastrophic events constantly looms over the people of Haiti, and the rise of the global temperature further places Haiti's environment and people at risk. Severe storms and drought are more likely in warmer climates, and Haiti's geographical position in the Caribbean places it in a vulnerable spot.

In terms of changes in climate in Haiti, the country is expected to become even hotter and drier. By 2030, the mean annual temperature is projected to increase by 0.5° C to 0.7° C, and by 2050, an increase of 0.9° C to 1.4° C is projected (ICF, 2024). As a result, climate-related hazards and natural disasters are expected to occur more frequently. "Floods, drought, intense rainfall, seawater intrusion, and hurricanes" will intensify current social, economic, and environmental stressors on the people of Haiti with a warmer climate (ICF, 2024). Furthermore, mean annual rainfall is projected to decrease by 3% by 2030 and 6% to 9% by 2050 (ICF, 2024). The reduction in water supply for crops will significantly impact Haiti's agricultural sector, which is very important to the country's economy. Many people in Haiti also depend on water catchment for drinking water and other daily water needs, and the supply of this necessary resource will also be depleted (ICF, 2024). In terms of rainfall, it is expected that there will be long droughts coupled with intense rain from tropical storms and hurricanes. This will intensify soil erosion, damage topsoil, and damage the water supply from rivers due to runoff from intense rainfall (ICF, 2024). Those living near riverbeds, ravines, mountain slopes, and on the coastline, as well as small farmers, are the most vulnerable to the impacts of climate change. Agriculture will be the most impacted industry/sector in Haiti, as soil and water sources will be damaged,

making the threat of food insecurity and its potential to be exacerbated even more prevalent with the decline of rainfall and the hotter temperatures (ICF, 2024).

Chapter 4: Political Efforts/Non-Efforts

This chapter will examine the politics of mass extinction and government efforts to mitigate and adapt to climate change. First, the efficacy of intergovernmental, national, and local policies and agreements will be explored. Then, the political turmoil of the politicization of mass extinction and climate change will be discussed, along with the positives and negatives of this situation. The chapter will end with a conversation about Haiti's governmental actions, its difficulties in making change, and the question of humanitarian and environmental aid.

What our Governments are Doing. In recent decades, federal governments and intergovernmental organizations have taken action to reduce the effects of climate change on biodiversity. This action may occur in two ways: adaptation and mitigation. Extinction adaptation involves preparing to endure a mass extinction, anticipating its effects on humanity in the future. Extinction mitigation concerns action was taken to prevent mass extinction, biodiversity conservation, and emissions reduction, for example. In recent years, The United Nations has united various governments to reduce biodiversity loss. The UN Framework Convention on Climate Change (UNFCCC) and the UN Convention on Biological Diversity (CBD) are two separate international agreements that involve commitments to reduce biodiversity loss and the effects of climate change (UN, 2023). Because mass extinctions are caused by global climate change, among other environmental transformations, efforts to reduce carbon emissions, conserve land and biodiversity, and prevent pollution improve biodiversity and reduce the likelihood of mass extinction. The UN CBD is a "legal instrument" for international biodiversity conservation, the sustainable use of biodiversity, and the fair sharing of these

resources across parties (UN, 2024). This convention was signed during COP15 in Rio de Janeiro in 1992. Furthermore, The United States was the only country not to ratify the 1992 COP15 treaty in which parties are in a Global Biodiversity Framework (GBF) under the CBD. This framework is particularly important as well as ambitious, as it includes plans to stop and reverse environmental degradation by "putting 30 percent of the planet and 30 percent of degraded ecosystems under protection by 2030." (Foote, 2022) The United States' neglect during COP15 and to this day is a significant step back in efforts to protect biodiversity, and the US itself holds an incredibly diverse number of species.

Other plans include restoring indigenous rights, aiding developing countries, and repairing ecosystems. The UNFCCC Paris Agreement went into force in 2016, and it is a legally binding treaty on climate change with 196 parties involved (UNFCCC, 2023). It involves actions concerning both mitigation and adaptation. The central goal of the Paris Agreement is to keep the global temperature increase below 2° C above pre-industrial levels and eventually below 1.5° C (UNFCCC, 2023). All parties involved make binding commitments to create, maintain, and communicate nationally determined contributions (NDC, found in Article 4 of the Paris Agreement), which vary depending on the socioeconomic status of the specific nation. These NDCs are a form of mitigation, as each country sets appropriate though ambitious goals to reduce the effects of climate change, while they report progress every 5 years and then set higher goals. Adaptation is another goal of the Paris Agreement, which is found in Article 7. National Adaptation Plans are established specific to each party, and they involve increasing resilience and reducing vulnerability to climate change both today and in the future (UNFCCC, 2023). The UNFCCC's Paris Agreement is a landmark international agreement that deals with preventing mass extinction through its efforts involving reducing the effects of climate change, land

conservation, and more. Because the Earth is reaching a point of mass extinction, it is essential that governments work cooperatively to prevent extinctions as much as possible.

The UNEP Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement among 184 countries. It was created in 1963 during a meeting with the members of the IUCN and was agreed upon in 1973. This agreement aims to govern the international trade of wild animals and plants so that these specimens do not endanger the survival of these species and others (CITES, 2024). This convention annually discusses the trade of a wide range of specimens, such as wild animals and plants and products made from them, leather goods, timber, and food. CITES was created to govern this trade internationally and across borders to establish sustainability and prevent these resources from diminishing. Principally, CITES works to prevent the over-exploitation of species used in international trade and currently protects over 40,000 species to various degrees. This convention is successful because none of the protected species have undergone extinction during the past 30 years (data from 1986-2016) (CRS, 2016). Though concerning implementation, CITES lacks strength in enforcing and enacting laws related to the treaty with certain parties (CRS, 2016).

Outside of the United Nations' various conventions mentioned in this section, several other organizations work to place more land and species under protection. To start, the World Wildlife Foundation (WWF) works locally and globally in almost 100 countries to protect, conserve, and rehabilitate ecosystems, species, and natural resources. Contrary to the UN conventions, the WWF is an independent non-profit charity that abides by Swiss law while acting internationally (WWF). Next, the Nature Conservancy (TNC) focuses specifically on land and water conservation. TNC works on all scales and with private businesses to place land under protection as a global environmental non-profit charity. According to TNC, this organization has

protected over 125 million acres of land (TNC, 2024). The Environmental Defense Fund (EDF) focuses on protecting natural systems in the U.S. As another non-profit environmental program, it is funded by grants and memberships (MacArthur Foundation 2021). Notably, some of the organization's funding comes from large fossil fuel companies, which may lead to a conflict of interest and prevent progress.

Concerning federal government action in the U.S., The Endangered Species Act (ESA) was enacted in 1973 (following the creation of the EPA), spearheaded by Congressman John Dingell with unanimous bipartisan support (Holst, 2020). The ESA is now 50 years old, and since then, 99% of the listed species have been "saved" from extinction (US DOI, 2023). This form of extinction mitigation has successfully taken direct action to conserve biodiversity in the United States, and it continues to hold bipartisan support (90% of Americans continue to support the ESA) (Holst, 2020). The Bald Eagle, a notable American symbol, is one of the species that were once endangered, though it still survives. This species is a tertiary consumer, incredibly important to a range of food webs, and was helped due to habitat conservation, the banning of Dichlorodiphenyltrichloroethane (harmful pesticide contaminating food sources), and public awareness and action concerning the preservation of the species. Mitigation is undeniably possible with proper policies and efforts that work to conserve and protect habitats, and the effort to protect the Bald Eagle must span all species. Though this act was enough to protect the Bald Eagle, among many other North American species today, climate change continues to be a looming threat to biodiversity and the survival of endangered species. Without mitigation concerning the rise of global temperature (among other climate changes), conservation will not be enough to save these species in the distant and near future.

According to the U.S. Department of State, the country “has committed significant financial investment towards the first national conservation goal of conserving at least 30 percent of U.S. lands and waters by 2030.” (US DOS, 2022) Although this conservation initiative in the U.S. is not assigned by the CBD, the “America the Beautiful” (ATB) project launched by President Joe Biden has the same goal. This initiative also has ambiguity and vagueness, as it does not clearly state what is meant by “conservation” and contains unclear methods of measuring the program's efficacy (Pleune, 2023). Another issue that is shared by both ATB and the CBD is the progress at which conservation has occurred. This results from a lack of communication between countries that share land intended to be conserved, as well as the ambiguity in the terms of these agreements (Dias, 2022).

Governments around the world have also implemented national laws to conserve land, among other efforts to reduce extinction rates and climate change. Venezuela has the highest percentage of conserved land, with 59.3% of its total land area protected, followed by Slovenia at 53.6% and Monaco at 53.4% (Haines, 2016). Only 12.9% of the U.S.’s land and inland water is currently under protection (USGS Communications and Publishing, 2021). Other efforts that impact extinction rates include carbon taxes and cap and trade. Carbon taxes are fees attached to the amount of greenhouse gas emissions that more significant GHG emitters must pay. This method of reducing GHG emissions is twofold: it acts as an incentive to lessen fossil fuel use, though it often doesn’t impact producers, being seen as merely a fee in the production process. However, it has proven successful in Sweden, as the national carbon tax implemented in 1991 reduced national GHG emissions by 27% (Council on Foreign Relations, 2023). Lessening GHG emissions through carbon taxes may reduce extinction rates, as species' struggle for survival would be less burdened as the global temperature rise stabilizes. The cap and trade system works

similarly to the carbon tax system, requiring companies and corporations to pay for emissions. Governments sell limited permits, permitting companies to emit only a certain amount of GHGs. This system is beneficial because there is a limit to the amount of permits the government will sell to companies, resulting in a limit on the total amount of emissions across the respective area. California adopted this system in 2013, and carbon emissions fell 10% between 2013 and 2018 (Council on Foreign Relations, 2023). Many countries have implemented adaptation policies to climate change and regional extinctions in various ways, depending on environmental conditions. Cities such as New York and Paris provide cooling centers to residents who do not have access to air conditioners during summers, which become hotter and hotter. The least attention from these governmental and international efforts has been focused on countries in the climate *precariat* (Wood & Meyer, 2022). It is essential that the countries that currently and will experience the most severe and dire impacts of climate change and extinction receive support to build more resilient communities and nations. With specialized international policies that meet the needs of each respective country, more individuals and communities will be able to endure through the coming years.

Politicization of Mass Extinction and Climate Change. The past mass extinctions that Earth has experienced have all been products of non-anthropogenic instances of catastrophe or environmental change. However, the one potentially occurring today is deeply rooted in political turmoil. In Bram Büscher's *Political Ecologies of Extinction* special section, he states, "the capitalist intensification of pressures on biological diversity combined with changing perceptions of the value of diversity during this time have led to a moment where extinction decisively moves from a biological endpoint to a political inflection-point," (Büscher, 2022). Büscher argues that the politicization of "environmental" problems downplays the urgency and

importance of the global dilemma. Climate change is often seen as an issue that can be fixed with a small policy change (Büscher, 2022). Furthermore, Büscher discusses that extinction rates are not as metric as they are often thought to be, as it is difficult to measure extinction in the same way that things such as CO2 are measured. Extinction is the last point in a long, destructive process. Thus, policy interventions become ineffective because of the inability to measure extinction sufficiently and the fact that extinction is delayed by other environmental changes (Büscher, 2022). Therefore, extinction mitigation must be taken preemptively with the utmost effort considering the conditions in which extinction occurs. Mass extinction mitigation and adaptation have, similar to climate change, become an issue of politics rather than an issue of the survival of humanity and the Earth that supports it.

As seen in American politics and other political systems around the world, an increasing polarity in political parties inherently includes the polarization of opinions concerning environmental issues. As stated in Chapter 2, the heightened awareness of global warming and the public awareness of climate change and extinction were succeeded by the politicization of climate change. Environmental activist groups arose after Hanssen warned the world about climate change, and in an effort to increase action, these groups actively pushed the politicization of the issue (Butler, 2018). The politicization of the environmental problems is twofold. Politicizing an issue so grand, urgent, and devastating can lead to a minimization of the problem. The act of politicization today can lead to it becoming a victim of political polarization, resulting in those affiliated with a particular partisanship disregarding the issue and actively working against resolving it. On the other hand, raising environmental issues in politics may lead to productive democratic debates and could hopefully guide governments to create solutions (Pepermans, 2016).

The rise and fall of the Environmental Protection Agency (EPA) is an example of the complexities of politicizing environmental issues. The EPA was created in 1970 by Richard Nixon. Environmental protection was certainly not Nixon's top priority, though the intense public pressure to act against pollution made it impossible to ignore it (Olden, 2018). Thus, the infamous Nixon administration created the EPA due to the public's politicization of the threat to human health and the environment. Following the creation, the American public was so satisfied with the work done by the EPA that they no longer saw a need for funding it. Citizens were finally comfortable with their surrounding environment and no longer experienced, nor did they reminisce about, the toxic air and polluted waters of the decades preceding the 1970s (Olden, 2018). Therefore, in recent years, more and more Americans have supported budget cuts to the EPA and other government organizations concerning climate change. Republican-controlled governments are responsible for the majority of these cuts, as this party is notoriously against spending government funds to combat climate change. Scott Pruitt, the former head of the EPA appointed by Donald Trump, also supported these cuts (Olden, 2018). An organization put into place out of public outcry and necessity was internally damaged due to politicization and polarization. Climate change, including mass extinction, is a victim of politicization because it has become an issue that is mostly supported by the left. Conservative parties actively work against actions taken to solve the problem and, as seen with many other political issues, will see little progress while the country continues to be polarized.

To encourage political action, many grassroots and activist groups around the world have campaigned for government action concerning the climate crisis since the 1980s. Examples of environmental activist groups are Fridays for Future, Greenpeace, Extinction Rebellion, Friends of the Earth, Earth Day Restore Our Earth, and Global Campaign for Climate Action.

Greenpeace, for example, was founded in 1971 in Vancouver, Canada, and uses various methods to intervene in negative anthropogenic habits, including peaceful protests, investigations, lobbying, and direct action (Greenpeace, 2023). Extinction Rebellion (XR), founded in the U.K. in 2018, is also a non-violent activist group known for disrupting public spaces to draw attention to its cause, among other activist methods such as protests. XR's main goal is to pressure government action to mitigate climate change, biodiversity loss, and social and economic struggles that result from these factors. XR is among the more "radical" activist groups that work to combat climate change, as they use confrontational tactics such as blocking traffic. In the time preceding COP28, protests took place across 65 countries to encourage solid, effective action in the agreement. Over 600,000 people joined to pressure the IPCC to make impactful decisions during the upcoming conference (Fisher et al., 2023). Thus, it is clear that many people around the globe feel a lack of responsibility and action from their governments as well as intergovernmental agreements and organizations. Some organizations seek to bring the voices of those impacted the most by climate change to the forefront, working for policy changes that lower extinction rates and remove the burden of climate change and biodiversity loss. In recent years, the Environmental Justice movement has been spurred by the general environmentalism movement, as many see that mainstream environmentalism does not account for the struggles experienced today by marginalized communities. Environmental issues are inherently intersectional, and grassroots Environmental Justice and general environmental movements seek to encourage governments to acknowledge and solve these issues.

A Look at Haiti's Government. Haiti has historically, and to this day, struggled with political instability, poverty, crime, food insecurity, natural disasters, and more. It is on the International Rescue Committee's 2023 Emergency Watchlist top 10 because of these issues,

including disease outbreaks and gang violence (IRC, 2023). These problems have only increased since the assassination of the former Haitian president Jovenel Moise in 2021, and about a month later, a 7.2 earthquake pushed the country into further economic and social crises (IRC, 2023). Inflation causes extreme difficulties in affording food for Haitian people, cholera outbreaks coincide with drinking water shortages, and humanitarian workers find it difficult to reach those in need due to gang violence and control (IRC, 2023). In October of 2023, the United Nations Security Council authorized the deployment of an "international security force" to assist Haiti's police against the widespread destructive gang violence, per the request of the Haitian government (UN News, 2023). The government of Haiti faces many difficulties in attempting to protect its remaining primary forests to total capacity because of these economic and political issues. UNEP and the Haitian government have placed areas under protection across the nation since 1968 to protect biodiversity hotspots. These areas comprise about 7% of Haiti's land and 1.5% of its waters, an essential step toward environmental recovery (UNEP, 2023).

Furthermore, Haiti is part of the Caribbean Biological Corridor, funded by the European Union and supported by UNEP, which includes Cuba and the Dominican Republic, countries with incredibly biodiverse ecosystems. Beginning in 2007, the ministers of the environment of these three countries made political declarations concerning their commitments to biodiversity conservation in this region. This organization includes ongoing projects, aid, and the creation of frameworks to work toward environmental recovery in the Caribbean that will eventually include permanent institutions to preserve land and help recover from natural disasters. Because Haiti is riddled with social and ecological issues, both aspects must be considered with care and respect for the other. Humanitarian work is a necessity for the people of Haiti, who experience food

insecurity, danger, natural threats, and more every day. At the same time, a healthy and resilient environment will improve these conditions.

The Papaye Peasant Movement (MPP) was founded in 1973 by Jean-Baptiste Chavannes and is a grassroots environmental justice movement that seeks to slow down and stop deforestation in the regions of Haiti that see the most poverty (Daniels, 2022). To address deforestation, Chavannes, an agronomist, worked to help Haitian farmers shift their practices to be more sustainable by teaching them methods such as drip irrigation and ways to avoid erosion on their land. The MPP helped more than 60,000 community members transition to sustainable agriculture practices by providing education and resources concerning water-saving irrigation methods and systems, natural and non-toxic fertilizers, and affordable erosion prevention systems. As a result, Haiti's people depend less on imported food, fewer farmers struggle with poverty, the water supply is better conserved, and fewer children are malnourished. The MPP helped improve Haiti's economic development due to these benefits for the agricultural sector (Goldman Environmental Foundation, 2023). Furthermore, the MPP worked to reforest Haiti's land to re-stabilize soil while building a larger agricultural economy by planting fruit trees. Although many of these trees have since been cut down to be used for fuel, the 20 million fruit trees planted have shown to be beneficial for agricultural production and preventing erosion while creating a healthier layer of topsoil (Goldman Environmental Foundation, 2023). The MPP demonstrates the importance and success of a grassroots movement during the climate crisis.

Chapter 5: Preventing a Mass Extinction

The final chapter will end the paper with a major policy recommendation considering mitigation and adaptation. Specifically focusing on the extinction dilemma, endangered species must be prioritized, and several frameworks will be suggested for mitigation. A strengthened

global conservation framework will also be recommended. The third section will discuss the importance of aid to countries in climate crises that intersect with humanitarian crises, and the ethics of assistance will be included. Then, the importance of a global shift in thought and relationship with the environment and biodiversity will be discussed to provide long-term solutions and symbiosis with nature through education. The paper will finish with the question of adaptation, which is often avoided, though necessary.

Extinction Mitigation. Mitigation and adaptation are essential in dealing with the potentiality of a mass extinction. Mitigation concerning the loss of species populations, biodiversity, and extinction loss must be prioritized. A strong mitigation hierarchy must be implemented to address the volume of species loss and falling biodiversity. There are gaps in current international plans and goals, and they do not include plans to address the main drivers of the biodiversity crisis (e.g., CBD, SDG). William N.S. Arlidge et al. suggest a global mitigation hierarchy for nature conservation, which involves four steps: avoid, minimize, remediate, and offset (Arlidge et al., 2018). This framework that conceptualizes all human biodiversity impacts aims to be integrated globally, and all nations would adhere to an ambitious paradigm. It addresses every possible outcome of a project that would impact biodiversity. For example, building roads in forestry to access forests results in a vulnerability for the surrounding areas, as it is now open to hunting, invasive species, and more (Arlidge et al., 2018). Thus, developers must set a biodiversity goal that will either result in no loss or a gain of biodiversity with clear and explicit terms and calculations before the project is embarked. This is *avoidance*, which includes finding and understanding the potential risks to species loss. Avoidance involves using techniques that will not harm or damage the surrounding environment and not developing projects in areas crucial to global, national, and local biodiversity and regions with high social

value, such as heritage sites. This step is critical, as avoiding impacts on biodiversity before the commencement of a project significantly lowers the following impacts (Arlidge et al., 2018). The second step is *minimization*, implemented into current projects and existing infrastructure. Environmentally friendly construction methods will be implemented, ecosystem service payments will be made, and lifestyle changes will be made individually. This step is vital because it will be implemented into preexisting habits currently causing biodiversity loss (Arlidge et al., 2018). *Remediation* involves addressing what areas and species are impacted and working to grow populations, replant forests, and remove invasive species for biodiversity to return to its pre-Anthropocene levels (Arlidge et al., 2018). Finally, the fourth step is to *offset* negative biodiversity impacts. This involves reviewing effects that remain after the first three steps and offsetting them in another area. If a developer wrongly assesses impacts before the project or commits to a lack of compliance, they must restore forest cover in another region, for example (Arlidge et al., 2018). Though this hierarchy is mainly focused on development, Arlidge et al. suggest that it can be used to address global biodiversity across every human impact on the planet, such as resource extraction, gas and oil use, agriculture, fisheries, and more (Arlidge et al., 2018). It should be implemented across all scales – global, national, and local, to address the main drivers of biodiversity loss and then move to the smaller drivers. There should be a global goal, in a similar light to the UNFCCC's goal to keep the global temperature rise under 1.5 degrees C, for biodiversity loss. Though this framework must be implemented with ambition, it must incentivize compliance, or little progress will be seen.

To prevent the endangerment of more species and the loss of species that are currently endangered, mitigation for climate change must also be included. As discussed in Chapter 4, the central goal of the UNFCCC is to limit greenhouse gas emissions through NDCs relative to each

party's resources and environmental conditions. The UNFCCC's Paris Agreement and Kyoto Protocol face several areas of inefficacy and insufficiency that will be addressed, mainly because the UNFCCC must strengthen its role in implementation. The UNFCCC has transitioned from an institution that monitors treaty negotiations to an institution that must support and monitor these treaties and the progress of the NDCs (Cogswell & Warszawski, 2022). By implementing higher standards of transparency and tracking the progress of the NDCs while also supporting countries that require further assistance, more progress can be made to prevent GHG emissions from rising and aid parties in transitioning to sustainable practices. The Paris Agreement includes an Enhanced Transparency Framework that must be reinforced to ensure accountability and complete transparency to allow for productivity and a strengthened understanding of effective methods and gaps in the NDCs (Cogswell & Warszawski, 2022). Furthermore, through growing the UNFCCC's bodies that focus on specific issues that are especially prevalent in developing countries, particular dilemmas that may be faced by certain parties – for example, internal conflict preventing progress or a lack of economic means – may be focused on with appropriate support from other parties (Cogswell & Warszawski, 2022). Thus, the UNFCCC must re-evaluate its supervision of implementation measures to provide aid to the parties that require further assistance and to ensure that each party meets its respective NDC so that climate change and mitigation measures can become more effective (Cogswell & Warszawski, 2022).

Global Conservation Framework. Focusing on conservation and preventing further species loss, E. O. Wilson was a biologist and naturalist who wrote *Half-Earth*, in which he suggested reserving half of the Earth's land and water to be left alone and untouched by humans. This land will be protected and left to function without anthropogenic intervention, thus allowing ecosystems to recover and species populations to rise (E.O. Wilson Biodiversity Foundation,

2024). The UN CBD's post-2020 Global Biodiversity Framework will place 30% of the Earth's land under protection by 2030, following a framework similar to that of *Half-Earth*. Even with 50% of the Earth's land unavailable to humanity, conservation efforts would inevitably compete with agriculture, infrastructure, and other lands used by humans, thus bringing concerns of social inequalities, the heightening of food prices, land sovereignty, and more. Furthermore, most of the 17% of the land currently conserved due to the CBD's goals is arid and either inaccessible or not used by humans. These obstacles now provide barriers to achieving the 50% of the land aimed to be conserved (Ellis, 2019).

To address these obstacles and to also place more than 50% of the Earth's land under protection to ensure that the world's biodiversity can be restored and maintained, the "Three Global Conditions for Biodiversity Conservation and Sustainable Use" global framework created by Earle C. Ellis will be suggested as a mitigation measure combatting extinction along with the global extinction mitigation hierarchy (Ellis, 2019). The main goal of this framework is to implement biodiversity conservation across the earth as a whole, including in cities and other places with high densities of human populations. The first condition under this framework is applied to land that is managed and sustained to support humans (Ellis, 2019). Through the implementation of productive and species-friendly agricultural methods, sustainable cities that support human, plant, and animal health within their borders, and methods of transportation and mobility that result in low contact and conflict with surrounding ecosystems, biodiversity can be supported both in land that is allocated for humans and in protected lands. The second condition concerns shared landscapes, land that continues to support biodiversity and is usually accessible and used by humans simultaneously (Ellis, 2019). These shared landscapes cover 56% of the Earth's land, and according to Ellis, they are made of 50% settlements and agriculture, while the

other 50% is made of land with high potential for conservation (Ellis, 2019). These areas may be used for forestry, grazing for livestock, and other land uses that involve little manipulation of the natural regions. By restoring and condensing the use of shared landscapes, key biodiversity areas may be allowed to recover. Implementing sustainable practices on these lands, such as less intensive and degradative methods of agriculture and timber harvesting, limiting the use of pesticides to natural and non-harmful solutions, and sustainable development – that is, housing and infrastructure that is existing or new be transformed into those that use energy and resources efficiently that are also equitable – will aid in transforming shared landscaped into those that benefit conservation. Thirdly, 26% of Earth's lands are currently not being used or altered by humanity and must remain as they are (Ellis, 2019).

With these conditions and understanding how the Earth's land is being used, it is essential to note that allotting 50% of land to humanity and the other 50% to be left alone will not be sufficient (Ellis, 2019). To embark on a global conservation plan, policy must be put in place to protect untouched land and restore, recover, and promote harmony with the land currently being used or degraded by humanity. Thus, implementing the global extinction mitigation hierarchy into the UN CBD's Global Biodiversity Framework will result in longer-lasting conservation and harmony. Under a new Global Conservation Framework specifically, 26% of the Earth's wild and unused land must be protected. Next, by 2050, half of the 56% of the Earth's land that contains shared landscapes will be restored, recovered, and protected. The rest, that is, 28% of the Earth's land, will be converted to shared landscapes that allow indigenous species to remain with sustainable agriculture methods and ethical extraction methods. Finally, the 18% of the land where most humans live and occupy will be restored by encouraging indigenous species to return and flourish in areas such as suburbs. In cities, sustainable architecture, development, and energy

will be implemented along with the encouragement of low-conflict interactions with wildlife (Ellis, 2019). With these implementations into the UN CBD's conservation goal, this framework results in 54% of the Earth's land under protection, 28% shared landscapes with implemented sustainable practices and the return and restoration of indigenous species and ecosystems, and 18% for dense cities that harmonize with surrounding ecosystems. There are certainly barriers to this framework, such as land sovereignty, food security, and the question of funding. The UN CBD's Global Biodiversity Framework must implement conservation into lands that are and will be used by humanity to allow for higher conservation goals and also to avoid losing land that is very much needed for today's societies.

Aid to Countries in Climate Crises. The countries that are seeing the highest losses in biodiversity and species are, most often, experiencing climate crises, which further result in societal devastation and species loss. Regions with intersected crises that include climate impacts, conflict, and societal issues must be prioritized because not only are these countries part of the climate *precariat* and seeing the most damage from climate change, but they also lack the resources to mitigate and adapt to the changing environment (Wood & Meyer, 2022). These conflicts may further affect the ability of these countries to accept and implement aid and frameworks to protect species due to political issues. The BASIC (Better Assistance in Crises) program searches for more efficient and more robust social and environmental assistance to countries in crises that will also provide long-term, sustainable solutions that address "social protection, humanitarian assistance, and climate adaptation and responsiveness" (Sabates-Wheeler et al., 2022). It is essential to consider when it is and when it is not appropriate to take humanitarian action and aid in other regions, and this must also be implemented into species protection and conservation because these actions have significant social impacts. The

likely most damaging effect of Anthropogenic environmental changes on countries in the climate precariat is the climate crises that result from these changes (Wood & Meyer, 2022). Climate crises affect both the humans and the species that live in these regions. For example, Haiti has been experiencing dire landslides, earthquakes, hurricanes, and more that have proven to be destructive both for the people as well as species populations. Haiti requires long-term disaster relief, among other implementations, though it is difficult because of crime groups and other issues (IRC, 2023). Thus, many countries are not receiving the aid required because of a multitude of internal issues as well as neglect from the climate *privileged* (Wood & Meyer, 2022).

Long-Term Symbiosis. Humanity's relationship with the environment has proven to be incredibly unequal and disconnected, specifically concerning Western societies. As explained previously in the *History of the Anthropocene* section of chapter 2, Western institutions and values prioritize economic gain and expansion over the health of the environment it uses for these benefits. This may very well be the result of ways of thought that come from widespread ideologies, philosophies, and ways of thought that place humanity's ability of technological creation, intelligent thought, and more above nature (Davis & Todd, 2017). Philosophies such as this have proven to be incredibly destructive, as this is commonly adopted by those countries that are climate *privileged,* causing the most harm to the Earth (Wood & Meyer, 2022). Thus, it is clear that to prevent mass extinction, mitigate climate change, and reverse Anthropogenic damage to the environment, societal changes in how climate change and nature are taught and thought about are required.

Humanity is, despite all of its damage to the environment, a part of the world's biodiversity. The current Anthropogenic extinction crisis intersects with "human culture and

ecosystem functioning" (Dirzo et al., 2022). To shift to societies that value humanity's relationship with the environment, it is required that expansionist ideas, including exponential growth and colonial/neocolonial philosophies that are ingrained in the way many societies think, are moved away from. The value of ecosystem services and the variety of species that inhabit the Earth are far more important to humanity than these Western priorities. Many plans to reduce and reverse biodiversity loss include incentives to the main drivers of climate change, making it more difficult to make concrete, long-lasting changes and allowing the social inequalities that come from existing systems to remain. Humanity must take on a "stewardship" that considers every environmental impact of waste, agriculture, energy, and much more, prioritizes the preservation of biodiversity, and allows for speciation. Steffen et al. recommend that this planetary stewardship has boundaries in which humanity can exist and change the environment. Furthermore, they suggest that a global, intergovernmental system should be polycentric and multi-level, steering away from the centralized hierarchies that have brought humanity to where it is today (Steffen et al., 2011).

Along with effective mitigation policy, it has been suggested that Indigenous philosophies be implemented, though not appropriated, to change how the environment is thought about (Davis & Todd, 2017; Kimmerer, 2022). In a chapter titled "Learning the Grammar of Animacy" in *Braiding Sweetgrass* by Robin Kimmerer, the indigenous language of Potawatomi is described. With only 9 speakers left that speak this language, almost every natural object and subject is animated and spoken of as if alive. There is no status difference in language between humans, trees, and rocks (Kimmerer, 2022). In biology classes, students learn the difference between a living and a non-living thing, creating a gap between humanity and nature. Treating nature as a separate sphere from humanity is a way of thinking that has caused mass

environmental destruction. Not only does this come from language, but it may originate from other institutions that create a general feeling of dominion over nature. To ensure that humanity will be able to live in symbiosis with nature rather than in another destructive sphere, the way the environment is thought about must be changed. However, this requires an incredibly drastic societal shift. Environmental education is essential, especially concerning relationships with nature, and more time should be spent outdoors cherishing the beautiful landscapes that remain.

Environmental education has expanded to many schools in recent years, though the contents of courses in K-12 education vary widely. Anna G. Cole recommends in *Expanding the Field: Revisiting Environmental Education Principles Through Multidisciplinary Frameworks* that the various cultural lenses of environmental justice should be implemented in education to understand environments. With more interdisciplinary approaches, students may not only understand climate change, its causes, and its consequences but also appreciate their interconnectedness with nature. As mentioned above, societal changes in how humanity thinks about the environment are essential in achieving harmony with the natural world. Thus, education concerning the impacts of consumerism, energy use, and expanding relationships with the outdoors would be instrumental in shaping the next generation and their relationships with the environment. As suggested by Cole, environmental justice education is key, as students can learn, discuss, and understand different perspectives of nature in a cross-cultural sense, as perspectives of the Earth vary so widely (Cole, 2007). Cole states that a new framework of environmental education "incorporates diverse perspectives of what it means to live well in a place" (Cole, 2007). Through the emphasis on interconnectedness with nature and humanity, students may be able to learn about methods and ways of thinking that reduce their individual impacts on the environment and that of the coming generations (Cole, 2007). This

interdisciplinary method of environmental education will also include the importance of scientific research surrounding climate change. Through experiments and other coursework, students will understand the gravity of climate change and their potential to take action, emphasizing the reality of the climate crisis and prioritizing fact-based education to prevent climate change denial. Interdisciplinary environmental education in K-12 public school systems can aid in the shift away from neoliberal and neocolonial patterns of thought that value extractivism, expansionism, and exponential growth and toward ways of thinking that value the Earth, relationships with nature, and equity regarding environmental justice.

Extinction Adaptation and Doomsday. Although adaptation is seen as a last-resort step in the long process of extinction prevention, it is necessary due to the volume of already lost species. Preparations for a mass extinction event are essential in dealing with an urgent situation, while current action leaves gaps and deficiencies (Novacek et al., 2001). As discussed in Chapter 2, biodiversity rates and ecological health did not return to the planet for millions of years when considering the recoveries from past mass extinctions. Considering how severely humanity has been able to alter and degrade the environment, humanity has the ability and the resources to restore environments and prevent species loss (Novacek et al., 2001). For example, reforesting areas depleted of their forests to mimic the primary forest cover would allow species to return to their previous habitats and thrive under these ecosystems (Liu et al., 2021). Re-evaluating and reinforcing aid in countries impacted by climate-related disasters is also an essential measure of adaptation, as many people today in countries that are susceptible to climate change experience dire impacts. Other adaptation measures include environmentally friendly methods of agriculture (ex., aquaponics/vertical farms to minimize the use of land, water, and energy if land becomes infertile), strengthening existing coastal infrastructures and homes, and creating resilience and

procedures for communities vulnerable to climate-related severe weather and natural disasters (Mukherjee et al., 2024). With adaptation measures in place, fewer communities will suffer the consequences of climate change and extinction because of the actions of the main drivers of climate change.

In Haiti, the current goals for adaptation measures are to conserve and manage water resources and watersheds, strengthen resilience in coastal zones and rehabilitate infrastructures on the coast, preserve and strengthen agriculture and food security, and educate the country's residents on sustainable practices and adaptation to natural disasters (ICF, 2024). Considering the success of the MPP in Haiti, education is incredibly important, as well as incentivization for farmers to transition to more environmentally friendly practices. By strengthening Haiti's NDC under the UNFCCC Paris Climate Agreement, coupled with economic and humanitarian assistance, Haiti may be better equipped for the future impacts of climate change as an incredibly vulnerable country. Not only will this help preserve and restore Haiti's wildlife and forests, but it will also help the people of Haiti by providing economic assistance, strengthened emergency response systems, and providing methods of agriculture that are productive and sustainable to improve food security. The main barrier in aiding Haiti's environment and people to recover and restore is the country's severe internal conflicts that have prevented development, and the failure to recognize that an appropriate balance between international assistance and intervention with locally led programs is required has further created conflict. Essentially, many concede that for Haiti to be able to solve its immediate problems, a governmental shift is required to allow for more transparency and then allow for international assistance while local efforts may continue (Mines, 2023). As emphasized earlier in this chapter, assessing when it is appropriate to intervene is important.

Another example of adaptation is seed vaults, which preserve seeds and breed those in danger of extinction. The purpose of "genebanks" is to preserve genetic diversity among plants and to make them available to improve food security. A notable facility is the Svalbard Global Seed Vault, one of 1,750 crop seed banks in the world, which has the capacity to store 4.5 million seed samples in multiple caverns at the end of a ~ 330 ft. tunnel on an archipelago in Norway (Asdal & Guarino, 2018). Genebanks worldwide send their seed samples to Svalbard, which has the perfect conditions with permafrost and generally cold weather if cooling systems fail (Asdal & Guarino, 2018). This seed bank is known as the 'Doomsday Vault' from Time Magazine, hence the grimness concerning extinction adaptation (Duggan, 2023). The painting of mass extinction and the acceleration of climate change as a doomsday scenario is realistic, though it creates anxiety surrounding the future. It has now become essential to build 'doomsday vaults' and facilities alike to prepare for the worst-case scenario. Adaptation is necessary not only for the impacts of climate change today but also to prepare communities and societies for the potential impacts in the future, and as a result of how severe Anthropogenic climate change has accelerated, it is now necessary to prepare for what may come in the future. With effective mitigation efforts that prevent further endangerment and loss of species, policies that work to stop and reverse climate change, an educational framework that promotes healthy and productive relationships with the environment, and preparations for the future, humanity may live in harmony with the environment in a changing and recovering Earth.

Bibliography

Albaladejo‐Robles, Gonzalo, Monika Böhm, and Tim Newbold. 2022. "Species Life‐history Strategies Affect Population Responses to Temperature and Land‐cover Changes." *Global Change Biology* 29, no. 1: 97–109. https://doi.org/10.1111/gcb.16454.

Arlidge, William N, Joseph W Bull, Prue F Addison, Michael J Burgass, Dimas Gianuca, Taylor M Gorham, Céline Jacob, et al. 2018. "A Global Mitigation Hierarchy for Nature Conservation." *BioScience* 68, no. 5: 336–47. https://doi.org/10.1093/biosci/biy029.

Asdal, Åsmund, and Luigi Guarino. 2018. "The Svalbard Global Seed Vault: 10 Years—1 Million Samples." *Biopreservation and Biobanking* 16, no. 5: 391–92. https://doi.org/10.1089/bio.2018.0025.

Avolio, Meghan L., Elisabeth J. Forrestel, Cynthia C. Chang, Kimberly J. La Pierre, Karin T. Burghardt, and Melinda D. Smith. 2019. "Demystifying Dominant Species." *New Phytologist* 223, no. 3: 1106–26. https://doi.org/10.1111/nph.15789.

Baraniuk, Chris. 2022. "The Animals Thriving in the Anthropocene." *BBC News*. https://www.bbc.com/future/article/20170801-the-animals-thriving-in-the-anthropocene.

Barash, M.S. 2017. "Environmental conditions as the cause of the great mass extinction of marine organisms in the Late Devonian." *Dokl. Earth Sc.* 475, 845–848. https://doi.org/10.1134/S1028334X17080013

Bond, David P.G., and Stephen E. Grasby. 2020. "Late Ordovician Mass Extinction Caused by Volcanism, Warming, and Anoxia, Not Cooling and Glaciation." *Geology* 48, no. 8: 777–81. https://doi.org/10.1130/g47377.1.

Bowman, Ron, dir. 2007. *6 Degrees Could Change the World*. National Geographic. https://www.youtube.com/watch?v=EU5tUY3W3WI.

Bowring, Samuel A., Douglas H. Erwin, and Yukio Isozaki. 1999. "The Tempo of Mass Extinction and Recovery: The End-Permian Example." *Proceedings of the National Academy of Sciences* 96, no. 16: 8827–28. https://doi.org/10.1073/pnas.96.16.8827.

Boyce, Daniel G., Derek P. Tittensor, Cristina Garilao, Stephanie Henson, Kristin Kaschner, Kathleen Kesner-Reyes, Alex Pigot, et al. 2022. "A Climate Risk Index for Marine Life." *Nature Climate Change* 12, no. 9: 854–62. https://doi.org/10.1038/s41558-022-01437-y.

Bryce, Emma. 2023. “Which Animals Are Most Likely to Survive Climate Change?” *LiveScience*. https://www.livescience.com/which-animals-will-survive-climate-change#:~:text=%22Generally%20speaking%2C%20small%20species%20are,risk%20under%20environmental%20change%2C%20too.

Büscher, Bram. 2022. “Political Ecologies of Extinction: From Endpoint to Inflection-Point. Introduction to the Special Section.” *Journal of Political Ecology* 28, no. 1. https://doi.org/10.2458/jpe.4828.

Butler, Colin. 2018. “Climate Change, Health and Existential Risks to Civilization: A Comprehensive Review (1989–2013).” *International Journal of Environmental Research and Public Health* 15, no. 10: 2266. https://doi.org/10.3390/ijerph15102266.

Ceballos, Gerardo, Paul R. Ehrlich, Anthony D. Barnosky, Andrés García, Robert M. Pringle, and Todd M. Palmer. 2015. “Accelerated Modern Human–Induced Species Losses: Entering the Sixth Mass Extinction.” Science Advances 1, no. 5. https://doi.org/10.1126/sciadv.1400253.

Chiarenza, Alfio Alessandro, Alexander Farnsworth, Philip D. Mannion, Daniel J. Lunt, Paul J. Valdes, Joanna V. Morgan, and Peter A. Allison. 2020. “Asteroid Impact, Not Volcanism, Caused the End-Cretaceous Dinosaur Extinction.” *Proceedings of the National Academy of Sciences* 117, no. 29: 17084–93. https://doi.org/10.1073/pnas.2006087117.

Chu, Jennifer. 2013. “Huge and Widespread Volcanic Eruptions Triggered the End-Triassic Extinction.” *MIT News | Massachusetts Institute of Technology*. https://news.mit.edu/2013/volcanic-eruptions-triggered-end-triassic-extinction-0321#:~:text=end%2DTriassic%20extinction-,Huge%20and%20widespread%20volcanic%20eruptions%20triggered%20the%20end%2DTriassic%20extinction,and%20terrestrial%20species%20on%20Earth.

CITES. 2024. “What Is CITES? | Cites.” cites.org. https://cites.org/eng/disc/what.php.

Climate Change Knowledge Portal. 2021. “Haiti.” *Summary | Climate Change Knowledge Portal.* https://climateknowledgeportal.worldbank.org/country/haiti.

Cline, Eric H. 2021. *1177 B.C.: The year civilization collapsed*. Princeton, NJ: Princeton University Press.

Cogswell, Nathan, and Nate Warszawski. 2022. “5 Challenges the UNFCCC Must Overcome To Spur Climate Action.” *World Resources Institute*. https://doi.org/https://www.wri.org/insights/5-challenges-unfccc-must-overcome-climate-action.

Cohen, Douglas, dir. 2008. *Life After People*. The History Channel. https://www.history.com/shows/life-after-people.

Cole, Anna Gahl. 2007. “Expanding the Field: Revisiting Environmental Education Principles through Multidisciplinary Frameworks.” *The Journal of Environmental Education* 38, no. 2: 35–45. https://doi.org/10.3200/joee.38.1.35-46.

Council on Foreign Relations. 2023. “How Do Governments Combat Climate Change?” Council on Foreign Relations. https://world101.cfr.org/global-era-issues/climate-change/how-do-governments-combat-climate-change.

CRS. 2016. “The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).” EveryCRSReport.com. https://www.everycrsreport.com/reports/RL32751.html#:~:text=Many%20believe%20that%20CITES%20has,the%20treaty%20in%20some%20nations.

Crutzen, Paul J. 2006. “The ‘Anthropocene.’” *Earth System Science in the Anthropocene*, 13–18. https://doi.org/10.1007/3-540-26590-2_3.

Crutzen, Paul J. and Stoermer, Eugene F.. 2000. “The ‘Anthropocene’”. *The Future of Nature: Documents of Global Change*, edited by Libby Robin, Sverker Sörlin and Paul Warde, New Haven: Yale University Press, 2013, pp. 479-490. https://doi.org/10.12987/9780300188479-041

Daniels, Joe P. 2022. “‘Local Is Better’: Battered Haiti Looks to Empower Peasants to Fight Climate Crisis.” The Guardian. https://www.theguardian.com/society/2022/jan/08/local-is-better-battered-haiti-looks-to-empower-peasants-to-fight-climate-crisis.

Davis, Heather, and Zoe Todd. 2017. “On the Importance of a Date, Or, Decolonizing the Anthropocene”. *ACME: An International Journal for Critical Geographies* 16 (4):761-80. https://acme-journal.org/index.php/acme/article/view/1539.

Diamond, Jared R. 2011. *Collapse: How societies choose to fail or succeed*. New York, NY: Penguin Books.

Dias, Braulio F.S. 2022. “The Slow but Steady Progress in the Implementation of the Biodiversity Agenda.” IUCN. https://www.iucn.org/news/world-commission-environmental-law/202007/slow-steady-progress-implementation-biodiversity-agenda.

Diouf, Ibrahima, Ibrahima Sy, and Moussa Diakhaté. 2024. “Assessing Climate Change Impacts on Public Health in Haiti: A Comprehensive Study of Disease Distribution, Modeling, and Adaptation Strategies.” *Frontiers in Tropical Diseases* 4. https://doi.org/10.3389/fitd.2023.1287499.

Dirzo, Rodolfo, Hillary S. Young, Mauro Galetti, Gerardo Ceballos, Nick J. Isaac, and Ben Collen. 2014. “Defaunation in the Anthropocene.” *Science* 345, no. 6195: 401–6. https://doi.org/10.1126/science.1251817.

Dirzo, Rodolfo, Gerardo Ceballos, and Paul R. Ehrlich. 2022. “Circling the Drain: The Extinction Crisis and the Future of Humanity.” *Philosophical Transactions of the Royal Society B: Biological Sciences* 377, no. 1857. https://doi.org/10.1098/rstb.2021.0378.

Dixon, Dougal. 1981. *After man: A zoology of the future*. London, UK: Breakdown Press.

Duggan, Jennifer. 2023. “Norway: ‘doomsday’ Vault Where World’s Seeds Are Kept Safe.” *Time*. https://time.com/doomsday-vault/.

Ehrenberg, Rachel. 2015. “Global Forest Survey Finds Trillions of Trees.” *Nature*. https://doi.org/10.1038/nature.2015.18287.

Ellis, Erle C. 2019. “To Conserve Nature in the Anthropocene, Half Earth Is Not Nearly Enough.” *One Earth* 1, no. 2: 163–67. https://doi.org/10.1016/j.oneear.2019.10.009.

E.O. Wilson Biodiversity Foundation. 2024. “What Is the Half-Earth Project?” E.O. Wilson Biodiversity Foundation. https://eowilsonfoundation.org/what-is-the-half-earth-project/.

EPA. 2024. “Causes of Climate Change.” EPA. https://www.epa.gov/climatechange-science/causes-climate-change#:~:text=Concentrations%20of%20the%20key%20greenhouse,in%20the%20last%20800%2C000%20years.

Erwin, Douglas H. 2001. “Lessons from the Past: Biotic Recoveries from Mass Extinctions.” *Proceedings of the National Academy of Sciences* 98, no. 10: 5399–5403. https://doi.org/10.1073/pnas.091092698.

Fallows, Mike, dir. 2002. *The Future is Wild*. Animal Planet. https://archive.org/details/the-future-is-wild.

Fauna & Flora. 2023. “Eastern Caribbean Offshore Islands Network.” *Fauna & Flora*. https://www.fauna-flora.org/projects/eastern-caribbean-offshore-islands-network/#:~:text=Despite%20comprising%20only%200.15%25%20of,of%20reptile%20extinctions%20since%201500.

Feynman, Joan, and Alexander Ruzmaikin. 2019. “Climate Stability and the Origin of Agriculture.” *Climate Change and Agriculture*. https://doi.org/10.5772/intechopen.83344.

Fisher, Dana R., Oscar Berglund, and Colin J. Davis. 2023. “How Effective Are Climate Protests at Swaying Policy - and What Could Make a Difference?” Nature News. https://www.nature.com/articles/d41586-023-03721-z.

Foote, Stephanie. 2022. “COP15 Ends with Landmark Biodiversity Agreement.” UNEP. https://www.unep.org/news-and-stories/story/cop15-ends-landmark-biodiversity-agreement

Foster, William J., Bethany J. Allen, Niklas H. Kitzmann, Jannes Münchmeyer, Tabea Rettelbach, James D. Witts, Rowan J. Whittle, Ekaterina Larina, Matthew E. Clapham, and Alexander M. Dunhill. 2015. “How Predictable Are Mass Extinction Events?” *Royal Society Open Science* 10, no. 3. https://doi.org/10.1098/rsos.221507.

Gabriella J. Spatola et al. 2023. “The dogs of Chernobyl: Demographic insights into populations inhabiting the nuclear exclusion zone.” *Sci. Adv*. 9, eade2537. DOI:10.1126/sciadv.ade2537

Galván, I., Bonisoli-Alquati, A., Jenkinson, S., Ghanem, G., Wakamatsu, K., Mousseau, T.A. and Møller, A.P.. 2014. “Chronic exposure to low-dose radiation at Chernobyl favours adaptation to oxidative stress in birds.” *Funct Ecol*, 28: 1387-1403. https://doi.org/10.1111/1365-2435.12283

Ghosh, Amitav. 2017. *The great derangement: Climate change and the unthinkable*. Chicago, IL: The University of Chicago Press.

Goldman Environmental Foundation. 2023. “Chavannes Jean-Baptiste.” Goldman Environmental Prize. https://www.goldmanprize.org/recipient/chavannes-jean-baptiste/.

Gowdy, John. 2020. “Our Hunter-Gatherer Future: Climate Change, Agriculture and Uncivilization.” *Futures* 115. https://doi.org/10.1016/j.futures.2019.102488.

Ghosh, Amitav. 2017. *The great derangement: Climate change and the unthinkable*. Chicago, IL: The University of Chicago Press.

Gowdy, John. 2020. "Our Hunter-Gatherer Future: Climate Change, Agriculture and Uncivilization." *Futures* 115. https://doi.org/10.1016/j.futures.2019.102488.

Greenpeace. 2023. "How Greenpeace Creates Change." Greenpeace UK. https://www.greenpeace.org.uk/about-greenpeace/how-we-create-change/#:~:text=Greenpeace%20investigates%2C%20documents%20and%20exposes,a%20green%20and%20peaceful%20future.

Haines, Gavin. 2016. "Mapped: The Countries Doing Most to Protect Their Land (#1 Might Surprise You)." The Telegraph. https://www.telegraph.co.uk/travel/news/mapped-the-countries-with-the-most-protected-areas/.

Heather Davis and Zoe Todd. 2017. "*On the Importance of a Date, or Decolonizing the Anthropocene*," ACME vol. 16, iss 4.

Hedges, S. Blair, Warren B. Cohen, Joel Timyan, and Zhiqiang Yang. 2018. "Haiti's Biodiversity Threatened by Nearly Complete Loss of Primary Forest." *Proceedings of the National Academy of Sciences* 115, no. 46: 11850–55. https://doi.org/10.1073/pnas.1809753115.

Hetem RS, Fuller A, Maloney SK, Mitchell D. 2014. "Responses of large mammals to climate change." *National Library of Medicine.* (July);1(2):115-27. doi: 10.4161/temp.29651. PMID: 27583293; PMCID: PMC4977165.

Hoffmann, A., Sgrò, C. 2011. "Climate change and evolutionary adaptation." *Nature* 470, 479–485. https://doi.org/10.1038/nature09670

Holst, Eric. 2020. "Maintaining Our Bipartisan Wildlife History." *Environmental Defense Fund*, (March). https://www.edf.org/ecosystems/maintaining-our-bipartisan-wildlife-history#:~:text=What%20is%20the%20purpose%20of,in%20the%20House%20of%20Representatives.

Hunt, Terry L. 2019. "Rethinking the Fall of Easter Island." *American Scientist*. https://www.americanscientist.org/article/rethinking-the-fall-of-easter-island#:~:text=Around%201200%20A.D.%2C%20their%20growing,war%2C%20famine%20and%20cultural%20collapse.

ICF. 2024. "Climate Change / Haiti: Interactive Country Fiches." Climate change / Haiti | Interactive Country Fiches. https://dicf.unepgrid.ch/haiti/climate-change#:~:text=According%20to%20Haiti%27s%20NDC%2C%20t,information%2C%20education%2C%20and%20awareness.

IPCC Archive. 2021. “Intergovernmental Panel on Climate Change History.” IPCC. https://archive.ipcc.ch/organization/organization_history.shtml.

IRC. 2023. “Haiti: Political Instability, Gang Violence and Disease.” *The IRC*. https://www.rescue.org/article/haiti-political-instability-gang-violence-and-disease.

IUCN. 2023. “The IUCN Red List of Threatened Species.” IUCN Red List of Threatened Species. https://www.iucnredlist.org/about/background-history#:~:text=Currently%2C%20there%20are%20more%20than,mammals%20and%2013%25%20of%20birds.

Johnson, Christopher N. 2023. “Past and Future Decline and Extinction of Species.” *The Royal Society*. https://royalsociety.org/news-resources/projects/biodiversity/decline-and-extinction/#:~:text=The%20main%20direct%20causes%20of,change14%2C%2016%20and%2017.

Kimmerer, Robin Wall. 2022. “Learning the Grammar of Animacy.” Essay. In *Braiding Sweetgrass*, 69–82. Vancouver, B.C.: Langara College.

Kolbert, Elizabeth. 2014. *The sixth extinction: An unnatural history*. New York, NY: Picador.

Krug, A. Z., and M. E. Patzkowsky. 2004. “Rapid Recovery from the Late Ordovician Mass Extinction.” PNAS 101, no. 51. https://doi.org/https://doi.org/10.1073/pnas.0405199102.

Koch, Alexander, Chris Brierley, Mark M. Maslin, and Simon L. Lewis. 2019. “Earth System Impacts of the European Arrival and Great Dying in the Americas after 1492.” *Quaternary Science Reviews* 207: 13–36. https://doi.org/10.1016/j.quascirev.2018.12.004.

Lau, Brent. 2019. “The Anthropocene Extinction.” *ArcGIS StoryMaps*. https://storymaps.arcgis.com/stories/73ab69fedac54685ae837562e3389d13.

Lewis, S., 2015. Maslin, M. Defining the Anthropocene. *Nature* 519, 171–180. https://doi.org/10.1038/nature14258

Lindsey, Rebecca, and Luann Dahlman. 2018. “Climate Change: Global Temperature.” *Climate.Gov*.

Liu, Tiedong, Kai Jiang, Zhaoyuan Tan, Qifang He, Hui Zhang, and Chen Wang. 2021. “A Method for Performing Reforestation to Effectively Recover Soil Water Content in Extremely Degraded Tropical Rain Forests.” *Frontiers in Ecology and Evolution* 9. https://doi.org/10.3389/fevo.2021.643994.

MacArthur Foundation. “Environmental Defense Fund.” MacArthur Foundation, 2021. https://www.macfound.org/grantee/environmental-defense-fund-1070/#:~:text=The%20mission%20of%20the%20Environmental,oceans%2C%20ecosystems%2C%20and%20health.

Marriott, Katy. 2014. “Could Rats Really Grow as Big as Sheep?” BBC Science Focus Magazine. https://www.sciencefocus.com/nature/could-rats-really-grow-as-big-as-sheep. Olden K. 2018. The EPA: Time to Re-Invent Environmental Protection. *Am J Public Health*. (April);108(4):454-456. doi: 10.2105/AJPH.2017.304303. PMID: 29513581; PMCID: PMC5844410.

Millennium Ecosystem Assessment Board. 2005. *Ecosystems and human well-being: Synthesis*. Washington, D.C.: World resources Institute.

Mines, Keith. 2023. “There Is a Path Forward in Haiti - but It’s Not the One We Are On.” United States Institute of Peace. https://www.usip.org/publications/2023/06/there-path-forward-haiti-its-not-one-we-are.

Montuma, Martini. 2023. “Haiti Facing the Challenge of Climate Change.” *UNICEF*, (October). https://www.unicef.org/haiti/en/stories/haiti-facing-challenge-climate-change#:~:text=The%20destruction%20of%20fields%20and,financial%20consequences%20in%20the%20community.

Mousseau, Timothy A. 2021. “The Biology of Chernobyl.” *Annual Review of Ecology, Evolution, and Systematics*, 109, 52, no. 87. https://doi.org/https://doi.org/10.1146/annurev-ecolsys-110218-024827.

Mukherjee, M. N. RoyS. DasD., M. N. Roy, S. Das, D. Mukherjee, Wanglin MaDil Bahadur Rahut, Wanglin Ma, Dil Bahadur Rahut, et al. 2024. “Mitigation and Adaptation Strategies for Global Change.” SpringerLink. https://link.springer.com/journal/11027.

NASA. 2024. “Evidence - NASA Science.” NASA. https://science.nasa.gov/climate-change/evidence/.

NASA. 2024. “The Causes of Climate Change.” NASA. https://science.nasa.gov/climate-change/causes/.

NOAA. 2021. “Climate Change Impacts.” National Oceanic and Atmospheric Administration. https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts.

Novacek, Michael J., and Elsa E. Cleland. 2001. “The Current Biodiversity Extinction Event: Scenarios for Mitigation and Recovery.” *Proceedings of the National Academy of Sciences* 98, no. 10: 5466–70. https://doi.org/10.1073/pnas.091093698.

Otto, Sarah P. 2018. “Adaptation, Speciation and Extinction in the Anthropocene.” *Proceedings of the Royal Society B: Biological Sciences* 285, no. 1891. https://doi.org/10.1098/rspb.2018.2047.

Pepermans, Y. and Maeseele, P. 2016. “The politicization of climate change: problem or solution?” *WIREs Clim Change*, 7: 478-485. https://doi.org/10.1002/wcc.405

Pimm, S. L.. 2023. "Conservation." *Encyclopedia Britannica* (September). https://www.britannica.com/science/conservation-ecology.

Pleune, Jamie. 2023. “Creating a Transparent Methodology for Measuring Success Within a Continuum of Conservation for the America the Beautiful Initiative.” *SSRN* 14, no. 529.

Racki, Grzegorz. 2019. “Chapter 44: Big 5 Mass Extinctions.” *Encyclopedia of Geology*.

Ramanujan, Krishna. 2014. “Study Proves Biodiversity Buffers Disease.” *Cornell Chronicle*. https://news.cornell.edu/stories/2014/10/study-proves-biodiversity-buffers-disease.

Ritchie, Hannah, and Max Roser. 2024. “CO2 Emissions.” Our World in Data. https://ourworldindata.org/co2-emissions.

Román-Palacios, Cristian, and John J. Wiens. 2020. “Recent Responses to Climate Change Reveal the Drivers of Species Extinction and Survival.” *Proceedings of the National Academy of Sciences* 117, no. 8: 4211–17. https://doi.org/10.1073/pnas.1913007117.

Sabates-Wheeler, Rachel, Jeremy Lind, Paul Harvey, and Rachel Slater. 2022. “Strengthening Responses at the Nexus of Social Protection, Humanitarian Aid and Climate Shocks in Protracted Crises: Basic Research Framing Paper.” *UK aid*. https://doi.org/10.19088/basic.2022.001.

Song, Haijun, David B. Kemp, Li Tian, Daoliang Chu, Huyue Song, and Xu Dai. 2021. “Thresholds of Temperature Change for Mass Extinctions.” *Nature Communications* 12, no. 1. https://doi.org/10.1038/s41467-021-25019-2.

Steffen, Will, Åsa Persson, Lisa Deutsch, Jan Zalasiewicz, Mark Williams, Katherine Richardson, Carole Crumley, et al. 2011. "The Anthropocene: From Global Change to Planetary Stewardship." AMBIO 40, no. 7: 739–61. https://doi.org/10.1007/s13280-011-0185-x.

Strona, Giovanni, and Corey J. A. Bradshaw. 2022. "Coextinctions Dominate Future Vertebrate Losses from Climate and Land Use Change." *Science Advances* 8, no. 50. https://doi.org/10.1126/sciadv.abn4345.

Staub, Caroline, Anne Gilot, Molene Pierre, Gerald Murray, and Rosalie Koenig. 2020. "Coping with Climatic Shocks: Local Perspectives from Haiti's Rural Mountain Regions." *Population and Environment* 42, no. 2: 146–58. https://doi.org/10.1007/s11111-020-00351-9.

Swaddle et al. 2008. "Increased Avian Diversity Is Associated with Lower Incidence of Human West Nile Infection: Observation of the Dilution Effect." *PLoS ONE*, 3 (6): e2488 DOI: 10.1371/journal.pone.0002488

Thomas, Chris D. 2013. "The Anthropocene Could Raise Biological Diversity." *Nature* 502, no. 7. https://doi.org/https://www.nature.com/articles/502007a.

TNC. 2024. The Nature Conservancy. https://www.nature.org/en-us/.

UN. 2023. "Biodiversity - Our Strongest Natural Defense against Climate Change." *United Nations*. https://www.un.org/en/climatechange/science/climate-issues/biodiversity.

UN. 2024. "Convention on Biodiversity." United Nations. https://www.un.org/en/observances/biological-diversity-day/convention.

UNEP News. 2023. "In Haiti, Communities Take Aim at Deforestation." *UNEP*. https://www.unep.org/news-and-stories/story/haiti-communities-take-aim-deforestation#:~:text=To%20preserve%20the%20country%27s%20biodiversity,the%20technical%20assistance%20of%20UNEP.

UNFCCC. 2023. "The Paris Agreement." *United Nations Climate Change*. https://unfccc.int/process-and-meetings/the-paris-agreement.

UN News. 2023. "Security Council Authorizes 'historic' Support Mission in Haiti | Africa Renewal." *United Nations*. https://www.un.org/africarenewal/magazine/september-2023/security-council-authorizes-%E2%80%98historic%E2%80%99-support-mission-haiti#:~:text=In%20what%20is%20being%20hailed,the%20strife%2Dtorn%20Caribbean%20nation.

UN SDG. 2019. “Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'”. *United Nations Sustainable Development Goals*. https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/.

US DOS. 2022. “Highlighting U.S. Efforts to Combat the Biodiversity Crisis.” *U.S. Department of State*. U.S. Department of State. Office of the Spokesperson.

US DOI. 2023. “The Endangered Species Act: Celebrating 50 Years of Success in Wildlife Conservation.” *U.S. Department of the Interior*. https://www.doi.gov/blog/endangered-species-act-celebrating-50-years-success-wildlife-conservation.

USGS Communications and Publishing. 2021. “Analysis of Updated USGS Database Finds Increase in America’s Lands and Waters Managed for Biodiversity: U.S. Geological Survey.” *USGS*. https://www.usgs.gov/news/technical-announcement/analysis-updated-usgs-database-finds-increase-americas-lands-and-waters#:~:text=The%20latest%20assessment%20indicates%2012.9,Status%20Code%201%20and%202.

UN SDG 2019. 2019. “UN Report: Nature’s Dangerous Decline ‘Unprecedented’; Species Extinction Rates ‘accelerating’ - United Nations Sustainable Development.” *United Nations*. https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/.

UN SDG 2023. 2023. “Global Partnerships - United Nations Sustainable Development.” *United Nations*. https://www.un.org/sustainabledevelopment/globalpartnerships/?gclid=CjwKCAjwgsqoBhBNEiwAwe5w0x_BkJ4QJHQGhnbfma3iQumUKVodpWHOlh7T6u54ju2lIyTFpD18HRoCXPwQAvD_BwE.

Weart, Spencer. 2012. “The Discovery of Global Warming.” *Scientific American* 68, no. 1. https://doi.org/https://www.scientificamerican.com/article/discovery-of-global-warming/#:~:text=Their%20worries%20first%20caught%20wide,to%20cut%20greenhouse%20gas%20emissions.

Williams, Vereda Johnson. 2011. “A Case Study of the Desertification of Haiti.” *Journal of Sustainable Development* 4, no. 3. https://doi.org/10.5539/jsd.v4n3p20.

Wood, Nick, and Faeza Meyer. 2022. “Just Stories: The Role of Speculative Fiction in Challenging the Growing Climate Apartheid.” *Psychology in Society*.

WWF. 2020. “How Many Species Are We Losing?” *WWF*. https://wwf.panda.org/discover/our_focus/biodiversity/biodiversity/#:~:text=These%20experts%20calculate%20that%20between,2%2C000%20extinctions%20occur%20every%20year.

WWF. 2022. “The 2022 Living Planet Report.” *HOME | WWF*. https://livingplanet.panda.org/en-US/.

Yuyang Wu et al. 2023. Volcanic CO2 degassing postdates thermogenic carbon emission during the end-Permian mass extinction. *Sci. Adv. 9*. DOI:10.1126/sciadv.abq4082

Zoological Society of London. 2023. “Living Planet Report.” *ZSL*. https://www.zsl.org/what-we-do/projects/living-planet-report.