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Term Project Proposal Draft

My term project will focus on how humans have caused the sixth mass extinction of animal and plant life on earth, including how our own short life spans and status as a relatively young species (in comparison to the whole lifespan and existence of Earth and its ecosystems), has warped much of our perspective on how alarming many of the ecological changes and dropping rates of biodiversity we see today, are.

Much of which I have learned since researching this subject matter is that although Earth has gone through five “mass extinctions” prior to the existence of the modern human, our impact on the environment has catapulted us towards yet a sixth. These past mass extinctions may be defined as radical biotic changes that are occurring globally. Caused by physical events, these global changes far outside the boundaries of normal climates, and often include major disturbances in biodiversity and crucial shifts in entire ecosystems. As an example of this, one of the more recent and well-known mass extinctions to have occurred is the fifth, in which multiple collisions between Earth and an extraterrestrial bolide (likely cometary), wiped out many of the remaining terrestrial dinosaurs and marine ammonites, as well as other species, at the end of the Cretaceous period [4]. The sixth extinction is said to be discernible in its two different phases. Phase one of the said “sixth mass extinction,” began when, shortly after *Homo sapiens* evolved out of Africa, the first modern humans began to disperse to varying areas of the Earth approximately one hundred thousand years ago [4]. Neanderthals, who had long lived in Europe, survived our arrival for less than 10,000 years, but then abruptly disappeared — victims, according to many paleoanthropologists, of our arrival through outright warfare or the more subtle, though potentially no less devastating effects, of being on the losing side of ecological competition [4]. Everywhere, shortly after modern humans arrived, many (especially, though by no means exclusively, the larger) native species typically became extinct. Human activity including disrupting ecosystems by overhunting game species, seen in North America in the butchering sites of mammoths, mastodons, and buffalo (which never experienced contact with humans before) and perhaps spreading microbial disease-causing organisms cumulated into the first ‘phase’ in which the steps towards the sixth mass extinction were taken [4].

Phase two is said to have arrived approximately ten thousand years ago with the invention of agriculture, with its invention, humans did not have to adhere to their ecosystem’s carrying capacity, and would overpopulate local ecosystems with favored plantlife that may serve as food crop rather than ‘weeds’ (a term more to serve as an indication of a plant life with a lack of use as food to the human population rather than serving to define their worth or importance on an ecological level) [4]. With the explosion of the human population, paired with eventual industrial society, more land was cleared for agricultural use and the erecting of suburbs, and humans continue to overfish and travel (leading to invasive species thriving at the detriment to the local populations), all while fossil energy use began to climb higher as well (in part to aid agricultural spread) further modifying the ecosystems [4]. And a sort of ‘looping process that occurs in human expansion, begins, as a larger population demands more (and

ultimately genetically modified) foods in order to sustain itself, leading to more agricultural development and industrial work (leading to a larger population), which ultimately finds its source in the high use of fossil fuels [7].

And the effects of this 'second phase,' can be seen in modern times in the startling increased extinction rate and decrease in population in amphibians, which may be able to indicate how human causation has affected its ecosystems. Amphibians are thermal conformers, making them sensitive to environmental temperature changes, which may be especially important concerning species with little acclimation to environmental temperature changes, when human activities (such as industrialism and manufacturing) have been known to have major impacts of global climates, and some of this can be seen in a study the article cites which estimates that current rates of extinction are two-hundred and eleven times the background extinction rate for amphibians [6]. Not only are human activities (such as pollution) causing the sharp changes in global climates that ultimately impact the amphibian populations (who are reliant on the thermal stability of their environments), but extinction rates have said to be further exacerbated by our habitat destruction, which is frequently accompanied by the use of pesticides and fertilizers. Another example of this is the *Panthera leo* (or lions), which were once distributed over most of Africa, southern Europe, the Middle East, and Northwestern India prior to 1900, and yet in modern era, they are confined to scattered populations in sub-Saharan Africa, and a remnant population in the Gir forest of India [2]. The most recent calculations, has estimated that wildlife abundance on the planet has decreased by as much as 58% between 1970 and 2012, and roughly a third of all land vertebrate species examined are experiencing declines and local population losses of a considerable amount, the diminishing and extinction of mammalian populations, though varied according to species, has been a global phenomenon, and, in sum by losing populations (and species) of vertebrates, we are losing intricate ecological networks [2]. In our efforts to produce and grow within our own competing nations on Earth, it seems that the concern over what we may be doing to our homes, and the many many living organisms that function to create balance within it, has been disregarded.

In a recent article published by the American Association for the Advancement of Science, researchers attempted to determine whether human activities are causing a mass extinction, while using "extremely conservative assumptions" (researchers conducted their cumulative research at 'conservative rates,' or underestimated calculations, in order to prevent claims of 'alarmist' behavior and to place a realistic 'lower bound' on humanity's impact on biodiversity). Statistics indicate that modern extinction rates are alarmingly high in the era of modern humans. Despite the use of conservative calculations, the scientists still found that 338 extinctions in vertebrate species have been documented since 1500, and that most of these extinctions have occurred with the last 114 years modern extinction rates [1]. The article also cites that the rate of modern extinction varies among vertebrate groups, as amphibians are shown a much more accelerated rate of extinction as "only 34 extinctions have been documented with a high level of certainty since 1500, yet more than 100 species have likely disappeared since 1980," and the authors emphasize that this may indicate a shortage of data for groups such as fish and reptiles, where many species have not been evaluated [1]. The research concludes that recent extinction rates are unprecedented prior to increased human activity, and are immensely unusual for Earth's history, and that the loss of this biodiversity may come in just three human lifetimes, and would mean another hundreds of thousands, or millions of years of diversifying the Earth. And yet in the perspective of the human lifespan (which is incomparably short in contrast to how

long it took the Earth and its ecosystems to develop the vast biodiversity we see today) 338 extinctions having been accounted for since the 1500's may initially be disregarded, and yet as the article states, the time and natural process it took to evolve such vertebrate species vastly outweighs the length of the modern human's lifespan, and perhaps its existence [1]. A common misconception is that the loss of two species a year may be of little concern, but when compared to the 'normal' extinction rate that has occurred in the last two million years, the extinction of two-hundred vertebrate species would have taken up to ten-thousand years to occur, a diffused estimate in comparison to the hefty loss of two species annually [2]. And the added fact that out of the 338, more than 100 of those species have been lost to us post-1980, may insinuate that the effect of a more industrialized world relying on fossil fuels, with the added rise and use of plastic in everyday goods, may have had an added effect on our environmental surrounding. These creatures and their ancestors (our ancestors perhaps) have taken millions of years to become the beloved and well known creatures they are today: creatures that aid our ecosystems in its web of relationships, are now being taken for granted and wiped out by the activities of humans, which oft go unregulated and unaware of the turmoil it creates.

Some solutions to such turmoil caused by the over reliance of fossil fuels has been suggested, one of these being a hypothesis that, as population and affluence are primary drivers of environmental impact, an economy that makes a shift towards more service-based products (such as healthcare) may contribute to a decrease in reliance on the production of energy, and may reduce environmental impact and the environmental threats a nation faces [3]. All these efforts may be calculated into the nation's environmental impact, an environmental footprint, or EF, which is taking basic forms of space consumption, such as crops, meat production, and living space, and converting them at world average productivity into varying types of biologically productive land and sea space (cropland, grazing land, etc.) [3]. EF measure how much of nature is exclusively used for producing all the resources a given population today, consumes, while the WF (water footprint) is rooted in the search to link human consumption, water use, global trade, and water resources management, defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community [5]. The strengths of such calculations, such as being able to capture the tradeoffs between things such as seafood production (water footprint) and meat production (grazing land and cropland footprint), but lacks an accounting of biodiversity loss, pollution emissions (excerpts for CO₂), that is is common to account for both bioproductive areas being used for resources and for areas that are needed as a 'sink' for the human pollution, and that global EF and WF figures show that certain types of consumption that activity that include travel, greatly contribute to the total appropriation of bioproductive space, and that energy use of society strongly contributes to it's EF [5]. Again the human perspective can either aid or negate this effect, as nations may be hesitant to make such seemingly drastic changes depending on their own historical use of their environment/land, and it is understandable that their own traditions or viewpoints, as well as aspirations to continue to grow as a first-world (or otherwise) nation, may warp further warp their views on the importance of environmental conservation efforts.

The major overarching scientific ideas that my project will be focusing on are humans have caused the mass extinction of biodiversity on earth, how such extinction has played out in its two phases since to introduction and evolution of modern man (and our spread across the globe), how what we have perceived about the commonality extinction (that it is common) is a result of the time we live in and the industries human interactions and activities have built.

Concentrating my topic on how humans have caused mass extinction of animal and plant life on earth, in relation to how our own perspective as a relatively young species on earth, has attributed to this, I would like my term project to use graphic design as a tool to visualize how human perspective has affected how we view the large scale existence of the Earth's ecosystem. Despite the fact that schools across the country largely teach about the formation of the Earth, and the billions of years of its existence, I feel we seldom are ever able to truly grasp how amazing it is that where we, and other existing organisms, are now is the culmination of millions of years of evolutionary efforts and mutations, and that organisms going extinct due to human activities are essentially the loss of such efforts, and the loss of biodiversity. I would like to link my project towards the key questions, "Why does extinction occur," and "How common is extinction?" and would like to create a large illustration in a poster format to exemplify this. I would like to use a vertically linear and hierarchical design, to depict the phases of our mass extinction as a sort of "clutter" of activities that are slowly being stacked on top of each other, teeter tottering at the top, to allude to how human impact on ecosystems and our own carelessness and ego didn't just start at the rise of industrialism, but have a foundation in our first ancestors (sort of like mid-way through a Jenga game, where the whole stack is unstable and about to collapse at any moment). For example, the bottom of the poster would depict some of the first modern humans surrounding a Woolly Mammoth, to signify the first phase, the root of when our unconcerning began. An illustration stacked on top of the first would perhaps be of primitive human developing agricultural crops, with some weeds being tossed to the sides as they make way for food crop, and this would signify part phase two. As more illustrations are stacked on top of each other, I would like to depict many now extinct species, such as the dodo bird, being tossed or falling off the sides, to show how species have been affected by our behaviors, and to also show how many species have been affected.

Project Table

Scientific Ideas	How these ideas may be incorporated into a creative work
<p>Past mass extinctions are radical biotic physical changes that are occurring globally that lay far outside the normal boundary of climates, and humans may have played a large role in creating such conditions in Earth's ecosystems (via pollution and heavy usage of fossil fuels), resulting in the developing conditions of the phases of the sixth mass extinction, as well as massive, rapid, and continuing loss of biodiversity.</p>	<p>This would be incorporated into my project via an illustration at the bottom of the poster to serve as the 'foundation' of the teetering tower of illustrations. The illustration would consist of humans surrounding a Woolly Mammoth to signify the first phases of the mass extinction, in which many game populations experienced decreases with the introduction of humans (due to hunting/overfishing). Another illustration would be stacked on top of that to portray phase two. This illustration would likely be of humans farming, to signify how agriculture, the removal of natural plant life for the growing of human food crop, also played a role in diminishing populations. Both illustrations would have the decreasing/extinct species falling off the sides to indicate how culminating human activities led to their eventual extinction.</p>
<p>All mass extinction events share several characteristics: they result from large-scale physical changes to the environment that happen over relatively short periods of time. Because these environmental changes are so great in magnitude and abrupt in occurrence, many species do not have the capacity to adapt and thus go extinct at a much faster rate.</p>	<p>Because species are going extinct at a much faster rate than they were, say one million years ago (when modern humans were not evolved to point which we are now), we are unable to grasp how much the extinction rate has gone up since the modern human's introduction to Earth's ecosystems, and our global spread. I would like my poster and illustrations to indicate and visually show just how many species have gone extinct since the 'beginning' of humans. This would be seen in the extinct species "falling off" the sort of Jenga tower of human chronology. I would like these aspects of my poster to create an awareness for just how many species humans have led towards extinction, and it to be a visual representation of how our activities have affected such species.</p>

Annotated Bibliography

- [1] Ceballos, Gerardo., et al. “Accelerated modern human-induced species losses: Entering the sixth mass extinction.” *Science Advances*, American Association for the Advancement of Science. 19 June 2015, <http://advances.sciencemag.org/content/1/5/e1400253/tab-pdf>

This research article functions to analyze and assess, “using extremely conservative assumptions, whether human activities are causing a mass extinction” . Citing a growing body of evidence that indicates that modern extinction rates are alarmingly higher in the era of modern humans, the article conducts cumulative research in at ‘conservative rates,’ (underestimated calculations) in order to prevent claims of ‘alarmist’ behavior as scientists and to place a realistic ‘lower bound’ on humanity’s impact on biodiversity and to obstruct. The article concludes that the recent extinction rates are unprecedented prior to increased human activity, immensely unusual for Earth’s history.

- [2] Ceballos, Gerardo., et al. “Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines.” *Proceedings of the National Academy of Sciences of the United States of America*, 10 July 2017. <https://www.pnas.org/content/114/30/E6089.short>

This article introduces the idea of the common misconception (perhaps caused by human perspective), that the loss of two species a year (a conservative and cumulative estimate of two-hundred lost species in the last one-hundred years) may be of little concern, but when compared to the ‘normal’ extinction rate that has occurred in the last two million years, the extinction of two-hundred vertebrate species would’ve taken up to ten-thousand years to disappear, a diffused estimate in comparison to the hefty loss of two species annually (Ceballos et al. 6089). The article continues that in the last few decades, habitat loss, overexploitation, pollution, and climate change have led to catastrophic declines in the populations of both common and rare vertebrate species, relating how many mammals that were relatively of low concern one or two decades ago are now endangered such as the *Panthera leo* (or lions).

- [3] Dietz, Thomas., et al. “Driving the human ecological footprint.” *Frontiers in Ecology and the Environment*, vol. 5, no. 1, *Wiley on behalf of the Ecological Society of America*, 1 Feb 2007, pp. 13-18, *JSTOR*, https://www.jstor.org/stable/20440554?seq=1#metadata_info_tab_contents

In this article Dietz et al., introduces the thought that populations and affluence have long been primary drivers of environment impact and also introduces concepts explaining that an economy’s shift away from industry and manufacturing, towards service-based industry may contribute to a decrease in reliance on the production of energy, and may reduce environmental impact. The authors continue on to delved into how a nation’s environmental footprint is calculated, as well as the drawbacks of the ecological footprint.

- [4] Eldredge, Niles. "The Sixth Extinction." ActionBioscience, 12 Aug 2009, <http://www.actionbioscience.org/evolution/eldredge2.html>

This source delves more into the how and why of human causation. The article defines the basics of mass extinction, as well the previous five mass extinction that had occurred in Earth history. The article continues from this to discuss the human causation behind the sixth extinction, parting it into two 'phase,' which begins from the emergence of the first modern humans, to our society's use of fossil fuels today.

- [5] Hoekstra, A.Y. "Human appropriation of natural capital: A comparison of ecological footprint and water footprint analysis." *Ecological Economics*, vol. 68, no.7, 15 May 2009, pp. 1963-1974. *ScienceDirect*, <https://www.sciencedirect.com/science/article/pii/S0921800908003078>

This article introduces an idea of the ecological footprint that is similar to Deitz, , but also relays that the ecological footprint (EF) concept was first rooted in the search for a way to measure how the modern human's influence on Earth's ecosystems relates to the carrying capacity of the Earth and in a search for indicators of sustainable development. EF measure how much of nature is exclusively used for producing all the resources a given population today, consumes, while the WF (water footprint) is rooted in the search to link human consumption, water use, global trade, and water resources management, defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community. The article furthers that is is common to account for both bioproductive areas being used for resources and for areas that are needed as a dumping grounds (of sorts) for the human pollution, and that global EF and WF figures show that certain types of consumption that activity that include travel, greatly contribute to the total appropriation of bioproductive space, and that energy use of society strongly contributes to it's EF, but not necessarily to its WF.

- [6] Vredenburg, Vance and David Wake. "Are we in the midst of the sixth mass extinction? A view from the world of the amphibians." *Proceedings of the National Academy of Sciences of the United States of America*, vol. 105, 12 August 2008, pp. 11466-11473. https://www.pnas.org/content/105/Supplement_1/11466.short

The article speaks on the how the startlingly increased extinction rate and decrease in population in amphibians may be able to indicate how human causation has affected its ecosystems, as changing temperatures are affecting the many species of thermal conforming amphibians (sensitive to temperature changes), possibly leading towards to that current rates of extinction are two-hundred and eleven times the background extinction rate for amphibians. The article adds that such global climate changes can have an equally large effect on others species that are sensitive or reliant on stable temperatures in their ecosystems.

- [7] Rees, William and Mathis Wackernagel. "Ecological Footprints For Beginners." Our Ecological Footprint: Reducing Human Impact on the Earth, New Society Publishers, 1 Jan 1996, pp 7-30.

This article repeats the idea that rather than humans being separate or above nature, we are apart of it, despite how we may otherwise portray ourselves. The book demonstrates how the ecological footprint and its calculations may aid in our understanding of how human actions impact our local and global environments, and in attempting to hypothesize how humans may live more sustainably, the book demonstrates what human actions have so strenuously impacted the Earth: including how our current economy encourages this process of manufacturing as a means of catering to our ever-growing population. The book explains the sort of 'looping process that occurs in human expansion, in how a larger population demands more (and ultimately genetically modified) foods in order to sustain itself, leading to more agricultural development and industrial work (leading to a larger population), and emphasizes a need to consciously work towards sustainability.