MOTHER OF THE FOREST:
CONTEMPLATING SPECIES ENTANGLEMENTS IN A SEQUOIA ECOSYSTEM

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A THESIS EXHIBITION PRESENTED TO OCAD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF FINE ARTS
IN
DIGITAL FUTURES

TMAC CENTER, APRIL 12-14 2019
TORONTO, ONTARIO, CANADA, APRIL, 2019
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ABSTRACT

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Mother of the Forest: Contemplating Species Entanglements in a Sequoia Ecosystem
Master of Fine Arts in Digital Futures
April 2019

Mother of the Forest: Contemplating Species Entanglements in a Sequoia Ecosystem is an immersive experience that explores the significance of symbiotic relationships in a sequoia tree's ecosystem through embodied perspectives of various species. Through this research project, *Mother of the Forest* inquires*: in what ways can immersive experiences represent a sequoia tree's ecosystem, in order to communicate to users various perceptions of time and space, symbiosis, climate change, and environmental changes over time?* Pairing scientific information with speculative design methods, *Mother of the Forest* applies a speculative fabulation methodology to exhibit theoretical concepts such as "kinship", "becoming-with", and "entanglements" in order to have users consider their own role in intertwined ecologies impacted by human activity, resulting in biodiversity decline and climate change.

KEY WORDS:

speculative fabulation, symbiosis, ecology, interactive narrative, immersive experience, virtual reality, speculative design, multispecies storytelling

ACKNOWLEDGEMENTS

DEDICATION

To my parents, Kevin & Kim Blair;

To my husband, Brett Caraway;

To my canine companions, Mogli & Clara;

Thank you for always creating a space of love and support.

I am lucky to call you my home.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 TREES AS STORYTELLERS

I love the way the sunshine drips down through the tree branches outside, echoing intricate patterns into my home. The way the wind gently sways the branches that bump up against my window. I love how the trees wrap themselves up in one another, seemingly separate on the surface, yet elaborately enmeshed under the soil. Sometimes they grasp on to one another, creating a canopy of tree weavings in the sky. Trees are complex species unto themselves. Yet, their complexity multiplies, as they reach out and support others in their ecological niche. Their branches become something like a highway for the squirrels in my backyard, transporting them from one destination to the next. They are home to the birds that call out for their partners; they are food to microscopic creatures lurking within their bark. They are the fundamental resource that helped shape my home; their limbs fuel the fire that keeps me warm during cold Canadian winters; their pulp provides a surface to absorb and record my creative thoughts. Something about these everyday connections feels so rich to me. Whether helpful or harmful, a tree's encounters with others exemplifies life's entanglement between myriad things.

I've had memories, experiences, what I might even define as relationships with specific trees throughout my life that still linger in my memory. There was the magnolia tree that I climbed as a child in my grandparents' front yard; there was the oak tree in California that kept me tethered to the earth as I swung high into the sky; there was the eradication of cedar trees (along with other environmental vanishings) in my hometown in Texas; there was also the oak tree I stood under as I celebrated the marriage between my husband and I; but it feels like a stretch to point to any one of these memories as *the* pivotal moment that led me to my interest in film, art and design for environmental activism. I think my past, present, and future is just tangled up in these assorted experiences with other living beings, and something about their presence brings me comfort, to know in moments of doubt that I am never truly alone in this world, that there are connections between things that I cannot altogether realize.

Trees have always left me in awe. I think it's something about their variety as a species, their form, their stature, their stamina, and what I believe to be, their wisdom. It's difficult for me to comprehend that some trees living today are estimated to be older than Stonehenge and the Pyramids (Stafford, 30). Trees have occupied a special place in the human imagination since time immemorial. According to the Bible, human life began with Adam and Eve in the Garden of Eden, where the tree of life and the tree of knowledge stood. The Buddha found enlightenment under the Bodhi tree. Even Isaac Newton's encounter with an apple tree led to the formulation of the law of gravity. All of these important tales of

human discovery exhibit interactions with a nearby tree.[1] Trees have also inundated our modes of communication. We visualize information through hierarchical tree structures; we make associations with our kin through family tree diagrams; we continue to call the connection between living things the tree of life. Trees have become metaphors to visualize and speak about complex systems, intricacies, and histories.

Trees have also been converted into symbols for cultural production. For example, trees have been used as marketing icons: Hilton Worldwide owns a hotel chain named "DoubleTree by Hilton" which uses a logo of a tree; outdoor wear manufacturer Timberland uses a logo prominently featuring a tree; Estée Lauder's *Origins* brand of cosmetics also uses a tree in its logo (Figure 1). Car air fresheners are even shaped and smell like trees. Tree symbolism extends beyond consumerism to governmental organizations. The U.S. National Park Service includes a sequoia tree in their logo. Canada also uses tree imagery: the famous red and white symbol on the Canadian flag depicts a maple tree leaf, representing "long-term stability", "indigenous credentials" and "perpetual habits of renewal", making it "so right across the vast land mass people can recognize their national tree in the woods" (Stafford, 9). Trees are also used for healing purposes. For instance, yew trees are used in pharmaceutical drugs to help treat ovarian, breast, and prostate cancer (Stafford, 34). And there is, of course, the obvious ecological importance of trees: they feed on carbon dioxide and in turn release oxygen, which

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[1] For more examples of trees and their ties to various human histories, cultures, and geographies, read National Geographic's 2017 article by Cathy Newman, "What We Can Learn from Trees" (Newman).

we require for our respiration; they provide us food; they provide us resources for shelter and warmth. Therefore, it is fair to say that trees occupy pivotal positions in both natural and cultural spheres, helping humans survive, thrive, and express their imagination, creativity, and history.

Figure 1. Examples of tree symbolism in brand logos.

Sources: "Media Kit." *DoubleTree by Hilton*, http://www.newsroom.hilton.com/ doubletree/page/media-kit. Accessed 13 Jan. 2019.; *Timberland*. Http://www.timberland.ca/. Accessed 13 Jan. 2019.; "Origins." *Estée Lauder Companies*, www.elcompanies.com/our-brands/origins. Accessed 13 Jan. 2019.

Our own stories often include trees, although they usually function in a supporting role or picturesque backdrop. They are props to advance human-centered stories. Yet, what if we considered the trees themselves as storytellers? What stories could a tree tell us of its vast life experiences?

In fact, we already look to trees for stories, from ecological to societal histories. Their rings can be read much like a book, displaying notable moments of their lives, from wildfires, to insect outbreaks, to climate conditions (National Oceanic and Atmospheric Administration). Some trees have been referred to as *witness trees*,

as living connections to our history (Yessis). [2] They have lived through historical moments, from wars to other tragedies, and many have battle scars that show their endurance through time. From cannonballs and bullets to fading names (some soldiers used trees to carve the names of their fallen comrades into their bark) there becomes an inextricable enmeshment between stories of human and tree pasts (Stafford, 14). Therefore, trees can provide us various types of stories to contemplate. Yet I wonder: would trees' stories of histories, presents, and futures look similar to our own? Or could we learn a thing or two from them?

Moreover, trees have many roles to play beyond storytellers: they are resources, species, habitats, and at a grander scale, ecosystems. Many species owe a debt of gratitude to trees for their existence, and trees in turn rely on other species for survival. Our lives are not in isolation: can trees show us that this journey through life is intimately tied to other creatures? Furthermore, could a tree's stories present us with a new perspective of our world?

In order to explore the concept of trees as species, storytellers, and ecosystems, I created *Mother of the Forest*. *Mother of the Forest* is a virtual reality immersive experience that explores the complex entanglements between creatures in an ecology through various speculated perspectives of species within a sequoia ecosystem. The species highlighted in this experience are all significant characters within a flourishing sequoia ecosystem. Taken together, these species' stories give

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[2] For more information on *witness trees*, see Mike Yessis's article, "These Five 'Witness Trees' Were Present At Key Moments In America's History" at Smithsonianmag.com (Yessis).

us some indication of the various aspects that help keep this ecology healthy and lively. These embodied perspectives involve different senses of scale, space, and time, allowing us to consider how individual actions combine to form a system with macro effects across vast stretches of space and time. Thus, my research-creation combines immersive technology with scientific information and speculative design methods, to create an enmeshment between science and art, scientific fact and fiction, information and speculation, physical and digital environments, pasts, presents and futures. This mixture of methods and theories challenges the nature-culture binary, pushing for a hybrid, amalgamated assemblage between an array of things. In doing so, my intention is to promote the role art can play in environmental advocacy, particularly as we face ecological destabilization due to human activity resulting in biodiversity decline and climate change.

1.2 RATIONALE

Although there is scientific consensus on planetary changes due to human activity, now commonly referred to as the "Anthropocene", it seems that scientific information has trouble gaining traction in general discourse about environmental issues (Crutzen and Stoermer, 17). According to the Yale Program on Climate Change Communication, in 2018 70% of U.S. citizens believed climate change is happening, yet only 57% believe it is caused mostly by human activity (Marlon et al.). Furthermore, only 36% discuss global warming occasionally and only 22% state they hear about global warming in the media at least once a week (Marlon et al.). How are we to persuade humans to change their own behaviors? Or better yet,

how might we convince large corporations or communities to change their damaging habits? How might we accomplish any of this when we are neither confronted with, nor discussing amongst ourselves, the environmental changes that are transforming the planet?

I believe that environmental communication is the answer to increasing individual agency in mitigating ecological crises, and I imagine a budding avenue for environmental communication is through artistic realms, and in particular, interactive media. Art can communicate scientific research in creative, interesting, and easily comprehensible ways. It also provides a space to imaginatively speculate new perspectives, thoughts, and futures. Today, interactive media is a popular form of entertainment that is relatively easy to share through online platforms. Through this research project, I explore virtual reality's ability to create a more promising space for environmental communication to flourish. I believe interactive, immersive experiences can be used to promote critical consideration and agency toward current planetary changes that will impact our future. They allow for creative ways to implement didactic and experiential learning methods, from visualizing and teaching environmental information, to allowing users to interact and actively engage with these environments and their beings.

1.2.1 RESEARCH QUESTION

Through this research-creation, *Mother of the Forest* considers the following:

in what ways can immersive experiences represent a sequoia tree's ecosystem, in order to communicate to users various perceptions of time and space, symbiosis, climate change, and environmental changes over time?

1.2.2 METHODOLOGY, METHODS, AND FINAL OUTPUT

Mother of the Forest uses a speculative fabulation methodology to produce this research-creation. Speculative fabulation, a term coined by Donna Haraway, is a "risky game of worlding and storying" that looks for tangled patterns and connections between "natures, cultures, subjects, and objects" in "multispecies worlds" (Haraway, 13). I use this methodology for my creative practice in order to fuse creative artistic practices and scientific research through the combination of interviews with park officials, 360 film, digital animations, creative prose, interactive media, virtual reality, and spatialized audio into one cohesive form. This results in the final thesis project, which consists of an interactive, immersive experience embodying different species, times, and spaces in a sequoia tree ecosystem. *Mother of the Forest* is created for users of all ages, paying special attention to users who may not have a high degree of digital media or virtual reality literacy, but nonetheless have the ability to evoke change through voting, donating, volunteering, and taking care of their natural surroundings. The final output of *Mother of the Forest* attempts to create a connection between individual agency,

collective interactions, different spaces, and intertwined pasts, presents, and futures to engage users in their own ecology.

1.3 PROJECT ROADMAP

Chapter 2 of this thesis document features a literature and contextual review, as well as my theoretical framework, in order to situate my work in these areas of scholarship. Due to the interdisciplinary nature of this project and the relevance between the literature, created works, and theories I am studying, these elements are interwoven. I have organized Chapter 2 into subsections based on the general themes explored in *Mother of the Forest*. These include: the Anthropocene: climate change and biodiversity decline; species entanglements, assemblages, and "becoming-with"; symbiosis; species' perceptions of time; sequoia trees and their ecosystems; science, technology, and art entwine; speculating narratives for possible futures; and other creative works in the field. I conclude chapter two by discussing how *Mother of the Forest* is situated in all of these themes, with a brief roadmap of the project. In chapter 3, I move on to describe my methodological approach and creative process, as I explain speculative fabulation and its application in my final thesis project. I use speculative fabulation through interviewing park officials, writing a script and storyboard that combines speculative fiction with scientific information, producing the immersive experience through 360 film, digital environment and virtual reality production, as well as creating soundscapes of sequoias through spatialized audio effects, voiceover, and score production. These different creative practices are fused

together to create *Mother of the Forest*. Chapter 4 describes the final output of *Mother of the Forest* as well as my overall reflection on this process. In Chapter 5, I conclude with a summary of my thesis process and results, and what the future of this project holds, as I plan to conduct user testing in order to reflect on the affordances and limitations of this immersive experience for environmental communication. Furthermore, I discuss the goals for the project and my future work as an artist, as well as the goals I believe we as a community should pursue in environmental advocacy.

LITERATURE REVIEW

This research project is multidisciplinary in nature; therefore, my contextual review draws on various fields, sub-disciplines, works of literature and other creative works. I organize my contextual review around significant concepts used throughout my thesis, weaving different disciplines together. In this chapter, I discuss the following topics: the Anthropocene: climate change and biodiversity decline; species entanglements, assemblages, and "becoming-with"; symbiosis; species' perceptions of time; sequoia trees and their ecosystem; science, technology, and art entwine; speculating narratives for possible futures; and similar creative works. I conclude by contextualizing *Mother of the Forest* within these areas.

2.1 THE ANTHROPOCENE: CLIMATE CHANGE AND BIODIVERSITY DECLINE

As climate change inaugurates a period of warming temperatures, melting glaciers, rising sea levels, and severe weather events, these planetary changes will have serious consequences for the species that inhabit the Earth. According to the United States Pentagon's *2014 Climate Change Adaptation Roadmap*, we will

likely see "global instability" resulting from adverse living conditions due to natural disasters, and depletions in water, food, and natural resources (qtd. in Scranton, 15). According to James Clapper, the United States Director of National Intelligence from 2010-2017, this climatic change will likely lead to mass human migrations and global conflict (qtd. in Scranton, 15). These changes will not only change the geopolitical structure, but will more importantly directly impact the capacity of many species to live and thrive on Earth.

In October 2018, the United Nations Intergovernmental Panel on Climate Change (IPCC) released a special report on climate change and its global impacts. In it, the IPCC states, "human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate" (IPCC, 4). This trend has already resulted in many planetary changes: for example, IPCC states that "trends in intensity and frequency of some climate and weather extremes have been detected over time spans during which about 0.5°C of global warming occurred" (IPCC, 4). Additionally, the IPCC states that "many land and ocean ecosystems and some of the services they provide have already changed due to global warming" (IPCC, 4). If these climate "extremes" have transpired with only a 0.5°C increase, what will result from an increase of 1.5°C or more over the next three or four decades?

Similarly, the International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species states that over 26,000 species are threatened with extinction,

which amounts to over 27 % of all species identified on Earth (Schmid and Farjon). World Wildlife Fund (WWF) also released a report in 2018 called the Living Planet Report which describes climate change and the effects of human activity on the planet. Their report asserts that there was "an overall decline of 60% in species population sizes between 1970 and 2014" (Grooten and Almond, 7). Furthermore, the report highlights that "nature is not just nice to have", as economic activity relying on nature is "estimated to be worth around US$125 trillion a year" (Grooten and Almond, 6). The report also states that, "exploding human consumption is the driving force behind the unprecedented planetary change", resulting in climate change as well as declining biodiversity (Grooten and Almond, 6). The report points to "overexploitation of species, agricultural [activity], and land conversion, all driven by our runaway consumption," as the dominant cause of biodiversity decline (Grooten and Almond, 26).

This is the Anthropocene- the geological epoch that reflects humanity's capacity to impact the livability of Earth. In their article, "The "Anthropocene"", Paul J. Crutzen and Eugene F. Stoermer discuss the planet's shift from the Holocene, covering the last ten to twelve thousand years, to a new epoch marked by humans' ability to transform the geologic forces of the planet (Crutzen and Stoermer, 17). Crutzen and Stoermer identify the various ways the planet has been shaped by human activity, pointing to phenomena such as overpopulation, urbanization, the overconsumption of fossil fuels, species extinction rates, and CO_2 emissions. They estimate the Anthropocene's beginnings date back to the 18th century, when greenhouse gas emissions were reported concurrently with the invention of the steam engine (Crutzen and Stoermer, 17). Crutzen and Stoermer acknowledge the

importance of responding to the Anthropocene, stating that "to develop a world-wide accepted strategy leading to sustainability of ecosystems against human-induced stresses will be one of the great future tasks of mankind" (Crutzen and Stoermer, 18).

While some believe the Anthropocene marks an opportunity, as it demonstrates humanity's ability to terraform for the future of our species,[3] others take a more critical approach, noting the impacts these changes will have on our society, environment, and persistence as an individual species, as well as our ecological system. Roy Scranton believes the Anthropocene teaches us to learn to die as a civilization, to understand "that this civilization is already dead," in order to let go of our current way of life (Scranton, 23). In other words, we can't continue life as usual; our previous ways of life must end, in hopes of developing more sustainable ones. Others, such as environmental historian Jason W. Moore, believe that capitalism has caused these environmental crises, referring to this epoch instead as the Capitalocene (Moore, 594).

Modernity compels us to replicate, innovate, progress and extend contemporary society for the sake of profit and growth. We receive "a barrage of messages that tell us to keep moving forward, to get the newer model, to have more babies, to get bigger. There is a lot of pressure to grow" (Tsing et al., G2). The economic

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[3] In Ursula K. Heise's book, *Imagining Extinction*, Heise references author Diane Ackerman, who claims that, "These days… we control our own legacy. We're not passive, we're not helpless. We're earth-movers. We can become Earth-restorers and Earth-guardians" (qtd. in Heise, 206).

imperative of growth has impacted the natural world. Ecosocialist theorist John Bellamy Foster proclaims that the planetary changes we are witnessing signify a phenomenon he refers to as the *metabolic rift* (Foster, "Marx and the Rift in the Universal Metabolism of Nature"). Foster bases this theory on Marx's understanding of humanity's relation to nature as a "social metabolism", where the "universal metabolism of nature" conflicts with humanity under capitalism (qtd. in Foster, "Nature"). This struggle between societal and natural metabolisms defines the ecosocialist theory of the metabolic rift. Foster states:

> No longer is nature seen as a *direct* external threat to humanity through forces like famines and disease. Instead, emerging or threatened global natural catastrophes are viewed as the *indirect* products of human action itself. We now live in what scientists have provisionally designated the Anthropocene, a new geological epoch in which humanity has become the dominant geological force, disrupting the biogeochemical cycles of the entire planet. This new reality has compelled a growing recognition of the limits of nature, of planetary boundaries, and of economic growth within a finite environment (Foster, "Nature").

Therefore, while capitalism asks for more growth, more resources, and more production in order to increase consumption, nature is unable to produce, restore, filter and digest the throughput capitalism needs to stay afloat. According to Foster, capitalism disrupts the balance of the once self-sustaining ecological systems of Earth.

In her 2017 book, *Staying with the Trouble*, Donna Haraway theorizes the importance of working alongside other species for better relations during the ecological crises of the Anthropocene. While she notes that "anthropogenic processes have had planetary effects, in inter-intra-action with other processes and species, for as long as our species can be identified (a few tens of thousand years)", this change from an Earth *with* humans to an Earth *by* humans changes everything (Haraway, 99). Haraway asks: "when do changes in degree become changes in kind? And what are the effects of bioculturally, biotechnically, biopolitically, historically situated people (not Man) relative to, and combined with, the effects of other species assemblages and other biotic/abiotic forces?" (Haraway, 99). While Haraway realizes the effects of humanity on the planet, she abandons terms such as Anthropocene and Capitalocene. Haraway argues that these terms focus solely on humans and their stories, providing us with an incomplete history. She argues that we do not make history in isolation, rather we work alongside other species (Haraway, 49). Furthermore, she claims that these epochs result in either a "too late" stance of the future, or the flawed idea that technology will fix it all.

Haraway employs a new epochal term, the Cthulucene, which she describes as "made up of ongoing multispecies stories and practices of becoming-with in times that remain at stake, in precarious times, in which the world is not finished and the sky has not fallen – yet. We are at stake to each other" (Haraway, 55). The Cthulucene changes the narrative of the Anthropocene: it positions human beings as "with and of the earth, and the biotic and abiotic powers of this earth are the

story" (Haraway, 55). She declares that it's time to break with individualism, as it destroys our ability to care for others. Instead, Haraway calls for living by and for each other through species entanglements, inviting us to "become-with" in the Cthulucene (Haraway, 16).

2.2 Species Entanglements, assemblages, and "becoming-with"

Human and animal assemblages have occupied human stories for centuries. Some of these assemblages were constructed on a literal level, as depicted in the mythological constructions of human-animal hybrids like centaurs, Medusa, sirens, harpies, and the Sphinx. Yet, these liminal beings were treated as monstrosities, muddying the waters of the great chain of being. This chain of being depicts the evolutionary ascent from the simplest forms of life to the most complex, beginning with the earth (rock) at the bottom, to plants, animals, humans and finally God as the perfect form (Margulis, 3; Hejnol, G88). [4] Yet, through scientific studies, we have discovered that we ourselves are built like these literary monsters, as liminal beings persistently in the making.

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[4] In his chapter, "Ladders, Trees, Complexity, and Other Metaphors", biologist Andreas Hejnol discusses the use of ladders and trees as metaphors in evolutionary science for classifying the order of living beings from simple to complex forms of life (Hejnol, G87). He highlights the importance of these metaphors, as their hierarchical structure bleeds into how we perceive and value nature (Hejnol, G92).

While a human being is typically thought of as a singular entity, this is, in fact, scientifically incorrect. The human body can instead be understood as many species and ecosystems, encapsulated within the human form. In his chapter, "Holobiont by Birth: Multilineage Individuals as the Concretion of Cooperative Process", developmental biologist Scott F. Gilbert discusses how organisms have situated communities within. Drawing from Eugene Rosenberg and Ilana Zilber-Rosenberg's hologenome theory, "an organism plus its persistent communities of symbionts" is referred to as a "*holobiont*" (Gilbert, M73). Gilbert notes that, while biologists have used this concept to understand plants as assembled organisms, there has been resistance to using this concept in animal biology, due to the notion of individuality. This dichotomy between individuality and the holobiont is important, because it "changes what it means to be a person" (Gilbert, M75). As "only about half the cells in our bodies contain a 'human genome'," with the remaining cells including "about 160 different bacterial genomes", we are composed of species within ecosystems, making us "not *anatomically* individuals at all" (Gilbert, M75). Like a nesting doll, these symbiotic relations are present on both vast and minuscule scales, oftentimes hiding beneath the surface and blurring what it means to be an "individual" in isolation from others.

Other human and animal assemblages have been less literal in form, instead taking the shape of relationships, from "companion species" to hidden strangers we share our habitat with (Haraway, 11). As species vanish in the ruins of the Anthropocene, these relations are important, as they make up our ecologies. These necessary entanglements are envisioned in Anna Tsing, Heather Swanson, Elaine

Gan, and Nils Bubandt's 2017 anthology, *Arts of Living on a Damaged Planet*. A collection of essays from scientists, creative writers, anthropologists, artists and scholars, *Arts of Living on a Damaged Planet* describes a thick web of stories between species and landscapes, in order to emphasize the urgency for multispecies relations in the Anthropocene. The anthology is divided into two sections: ghosts and monsters. Tsing et al. describe ghosts as "anthropogenic landscapes haunted by imagined futures" who "help us read life's enmeshment in landscapes" (Tsing et al., M2). Tsing et al. claim that modern society asks us to forget what was there before, yet these ghosts show pasts that conflict with the present and future. Meanwhile, monsters are described as those who "point us toward life's symbiotic entanglement across bodies" as "wonders of symbiosis *and* the threats of ecological disruption" (Tsing et al., M2). These monsters trouble the idea of individualism, instead indicating the complex web created between all forms of life. Through scientific research, theory, creative writing and artistic practice, *Arts of Living On a Damaged Planet* urges humans to look at both our forgotten past and our complicated present to determine the fate of our uncertain future. It pushes us to respond, to not give up, and to never forget those that are living amongst us.

Therefore, as humans have survived *internally* through bodied species assemblages, we must also learn how to survive *externally* through time-space-species entanglements for more promising futures. Donna Haraway calls these codependent involvements an occasion of "becoming-with" (Haraway, 11). "Becoming-with" is a "model system in which scientists, artists, ordinary members

of communities, and nonhuman beings become enfolded in each other's projects" (Haraway, M35). "Becoming-with" is learning how to produce stories and lives with one another, both humans and beyond. This is the ability to craft partnerships, to learn how to survive through the care and attention of others.

2.3 SYMBIOSIS

Species entanglements and relations may seem like imaginative tales out of a storybook- yet, they are situated in our tangible existence. These relationships drive the evolutionary systems of life. The scientific term for these relationships is *symbiosis.*

The term *symbiosis* was originally created by German botanist Anton deBary, who defined it as "living together of differently named organisms" (qtd. in Margulis, 33). In her book, *Symbiotic Planet: A New Look at Evolution* (1998), renowned evolutionary theorist and biologist Lynn Margulis discusses the connection between symbiosis and the Gaia hypothesis, a concept developed by chemist James E. Lovelock that theorizes Earth as a living system (Margulis, 2). Margulis claims that living systems and evolution are made possible through symbiosis, rather than the Darwinian theory of natural selection. Symbiosis has many forms: relationships can be mutualistic (both species benefit), parasitic (one species benefits while the other is harmed), and commensalistic (one species benefits

while the other is not affected). These relations can be mandatory to survive, or they can be optional.

While Margulis believes "we cannot put an end to nature; we can only pose a threat to ourselves" (Margulis, 128) Tsing et al. state that "symbioses are vulnerable; the fate of one species can change whole ecosystems... This is one of the challenges of our time: entanglement with others makes life possible, but when one relationship goes awry, the repercussions ripple" (Tsing et al., M5).

When species become entangled in one another, it makes it difficult to portray one independently from the other, as they change each other's worlds. Entanglement demonstrates the need for more holistic views of nature. Holism refers to looking at a system as an interconnected whole, rather than dividing it into its separate parts to study in isolation. It refers back to the common phrase, "the whole is greater than the sum of its parts". Holistic thinking is often used in ecological science, as the outcomes of one species affect others in their ecological niches. As Haraway explains, "the more one looks, the more the name of the game of living and dying on earth is a convoluted multispecies affair that goes by the name of symbiosis, the yoking together of companion species, at table together" (Haraway, 124). This "game of living and dying on earth" as it pertains to declining biodiversity requires conservation that looks beyond specific individual species to their symbiotic partners and habitats. Entangled living, cooperation and relations require a holistic view that spans various species, landscapes, and times.

2.4 SPECIES' PERCEPTIONS OF TIME

As species work beside, with, and against one another through symbiotic relations, it's important to consider how time plays a role in ecological systems. What can the rate of change on earth through the measurement of time indicate about the present precarity of life due to human activity? Furthermore, how does a species' perspective of time impact their perceptions and actions within their niche? How does our human sense of time change how we look backwards and forwards, to histories, presents and futures?

In the vast history of the Earth, the Anthropocene takes up a very small sliver of time. The Earth is estimated to be around 4.54 billion years old ("Age of the Earth"). The Holocene, which marks the age of human after the last ice age, is estimated to have begun about 11,700 years ago (Stromberg). While the concept of the Anthropocene is contested by some geologists, many mark the Anthropocene as beginning in either the industrial revolution (1800's) or the atomic age (1950's) (Stromberg). In the grand scheme of its life, the rate of change that the Earth has experienced from the Anthropocene is astonishing. Tsing et al. make a significant point: "The word [Anthropocene] tells a big story: living arrangements that took millions of years to put into place are being undone in the blink of an eye" (Tsing et al., G1).

In a fascinating study about various perceptions of time, scientists Kevin Healy, Luke McNally, Graeme D. Ruxton, Natalie Cooper, and Andrew L. Jackson report in their article, "Metabolic rate and body size are linked with perception of temporal information" (2013) that species of different body sizes and metabolic rates perceive information at different time scales (Healy et al., 685). These "temporal resolutions" impact how we perceive the passage of time. Healy et al. state that "body size and metabolic rate both fundamentally constrain how species interact with their environment, and hence ultimately affect their niche", therefore signifying that a species' perception of time makes an impact on their survival, as well as how the ecosystem operates (Healy et al., 685). After conducting a test using CFF (critical flicker fusion frequency) on a wide variety of vertebrate species, they found that species with smaller sizes and higher metabolic rates perceive information over "finer timescales", which can be interpreted as time passing more slowly for these creatures (Healy et al., 685).[5] On the other end of the scale, "larger vertebrates, along with those with low metabolic rates, had lower temporal resolution" (Healy et al., 689). This leads to a larger timescale to process information, which can be interpreted as time moving faster for these creatures.

Unfortunately, humans seem to tend to look at chunks of time that measure in human lifespans rather than evolutionary timescales. Tsing et al. note that the prior "deep time of geology, climate and natural science is collapsing into the historical time of human technology" (Tsing et al., G12). In his chapter titled,

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[5] CFF (critical flicker fusion frequency) can be described as the measurement of the lowest frequency at which a flashing light is perceived as constant (Healy et al., 686).

"Future Megafaunas: A Historical Perspective on the Potential for a Wilder Anthropocene", biologist Jens-Christian Svenning discusses the future of megafaunas (species that are larger than 45 kilograms of body mass) as they are disappearing from Earth due to anthropogenic effects (Svenning, G67). I have chosen to include this article for a particular concept Svenning discusses: the "shifting baseline syndrome" (Svenning, G68). Svenning describes the "shifting baseline syndrome" as a scientific term that refers to "our tendency to imagine that environmental conditions at the edge of our own memories represent the way the world used to be" (Svenning, G68). This makes it difficult for humans to imagine what landscapes, ecologies, and ecosystems before their particular lifetime looked like.

In order to combat this "shifting baseline syndrome", I believe it's important to practice looking back in time before our personal, and perhaps even human, lifetimes. Perhaps looking beyond human timescales to consider the past, but also the future, of our ecologies can help us understand the rapid changes arising in current species and ecosystems- particularly in a forest of ancient beings.

2.5 Sequoia trees and their ecosystem

Forests, and to a grander scale, human life, are the result of fungal-plant symbioses. According to Margulis, "Land dwellers may owe their hold on dry ground to specific symbioses between plants and fungi… Together, fungal-plant complexes settled inhospitable dry regolith: sand, soil, and pebbles" (Margulis, 106-107).

Forests are important for survival all over Earth. Trees provide oxygen, food, and habitat for the rich array of creatures residing within the forests of the world. Forests also provide for those of us on the fringes of these ecologies, from their role as carbon sinks, to oxygen, resources, food, shelter- they even provide psychological effects by lowering our stress. [6] Yet many of these forests are vanishing due to agriculture, logging operations, and human development. Currently, only five countries on Earth hold most of the Earth's remaining "wilderness" (Meixler). [7]

Trees are not just stagnant objects that take up space in landscapes, gardens, homes, advertisements and virtual worlds. When given the opportunity, trees flourish, creating a tangled web of connections between their fellow companions and nearby visitors. In his book *The Hidden Life of Trees* (2015), forester and writer Peter Wohlleben combines scientific information, storytelling, and his own accounts as a forester to chronicle the lives of trees as social beings. Wohlleben discusses how forests work together as "superorganisms" by providing nutrients and information to one another through fungal networks and enwrapped roots (Wohlleben, 3). Wohlleben refers to this as the "wood wide web" (Wohlleben, 11). Furthermore, trees that are linked to many other trees in the forest are referred to

[6] For more information on nature's effect on our stress and ability to improve our cognitive functioning, read Florence Williams' article in National Geographic, "This is Your Brain on Nature" (Williams).

[7] According to Eli Meixler's article, "Just Five Countries Hold Most of the World's Remaining Wilderness, a New Report Says", Russia, Canada, Australia, the United States, and Brazil contain 70% of the remaining wilderness (or natural ecosystems) on Earth (Meixler). With a political shift to the right for many of these countries, it's a scary thought to consider what the future holds for these ecosystems.

as "mother trees" by ecologist Dr. Suzanne Simard (Wohlleben, 33). These trees send many nutrients to the younger trees nearby. While I found Wohlleben's book useful for the information it provides, in itself, the publication and reception of Wohlleben's book also serves as an interesting account of the recurring frictions between the scientific community and the humanities. His book was criticized by some in the scientific community for its anthropomorphic storytelling style that allegedly called into question the scientific validity of his arguments. This tension between creative storytelling and precise communication of scientific information is a tension that I have come up against in my own work.

My thesis project looks at a particular tree species: the *Sequoiadendron giganteum* (giant sequoia). In his book, *Ancient Sentinels: The Sequoias of Yosemite National Park* (2018), ecologist H. Thomas Harvey recounts the history, ecology, and future of the *Sequoadendron giganteum* as a species through a comprehensive overview of the sequoia groves in Yosemite National Park. Additionally, former National Park Service ranger William C. Tweed discusses the entwined histories between sequoia trees and humans in his book, *King Sequoia: The Tree That Inspired a Nation, Created Our National Park System, and Changed the Way We Think about Nature* (2016). Through personal experiences and extensive research, Tweed uncovers how sequoias have shaped human pasts, presents, and potential futures, as he urges us to treat these trees with respect. According to Tweed, these trees have remained a favorite among humans for three reasons: they are "very large", "very old", and very "rare" (Tweed, xvii).

While sequoias were known by their native inhabitants, the Miwok and the Western Mono, for centuries, the sequoias remained unknown to Euro-Americans until the 1840s-1850s gold rush (Tweed, 2). At the time, these trees were treated as human property, as well as resources: not for the quality of their wood (as they are brittle in nature), but rather as a spectacle. In the 1850s, a tree known as Discovery Tree was stripped of its bark. Its flayed pieces were then transported and later reassembled at an exhibit afar, in order to display to society one of nature's greatest wonders (Tweed, 5). "The "Mammoth Tree" exhibit took the form of a bark-confined room some twenty-five feet in diameter and twenty feet high with a sequoia-wood floor" (Tweed, 6). Chairs were placed inside this room, which was also available for dancing (Tweed, 7). Two years later, the tree parts were placed in storage and destroyed by a fire (Tweed, 9). Tweed notes, "We can only wonder whether anyone noticed the irony that a tree that had endured for more than 2,000 years in the wild ended up as a commercial exhibit that lasted barely two years" (Tweed, 9). Back in California, a hotel was constructed in the same grove of the Discovery Tree site. This included a dance floor on top of the Discovery Tree's 1,244 annual growth ring stump, as well as a bowling alley on top of the fallen Discovery Tree log (Tweed, 14).

Another tree, called "Mother of the Forest", was destroyed in a similar fashion. This Calaveras Grove tree was encased in scaffolding in order to remove the tree's bark from the living trunk (Tweed, 9). Mother of the Forest was essentially stripped alive (Figure 2). Its bark was displayed at New York's Crystal Palace. This bark was also destroyed later due to a fire in a building. Meanwhile, the remaining tree back

in Calaveras Grove died soon after its desecration (Tweed, 13). Mother of the Forest's remains became a tourist destination. A spiral staircase was attached to "the vertical skeleton of Mother of the Forest" and visitors carved their names into its remnants (Tweed, 16).

FIGURE 2. Vischer, Edward. *Mother of the Forest,*

(1855 and 1861) and other Groups, Plate IV. 1862. Lithograph.

Source: Vischer, Edward. Mother of the Forest, (1855 and 1861) and other Groups, Plate IV. 1862.

Online Archive of California, oac.cdlib.org/ark:/13030/tf696nb7b5/? brand=oac4. 10 Jan. 2019.

These trees that had previously stood the test of time fell instantly to the human need for fame and greed, as *manifest destiny* grasped ahold of the sequoias and

ran with them (Tweed, 14). This thesis project is named after Mother of the Forest to honor its legacy and its ultimate demise at the hands of human "progress". As renowned science fiction writer Ursula LeGuin proclaims, it's important to look past these trees as objects or resources; to see them as species and ecosystems, is "to class them as fellow beings - kinfolk" (LeGuin, M16).

The destruction of these forests led to their eventual protection through the Yosemite Grant of 1864. This grant made the lands inalienable "forever" (Tweed, 38). According to Tweed, "Many historians recognize this as the first clear legal expression of what would later become the national park idea" (Tweed, 38). In 1890, the Yosemite National Park was established (Harvey, 26). Therefore, sequoias have helped build the United States National Park system as it stands today.

Although this protection was intended to last "forever", recent events demonstrate how precarious this protection actually is. In 2017, United States President Donald Trump ordered the Department of Interior to review 27 national monuments designated under the Antiquities Act of 1906 (U.S. Department of the Interior). One of those monuments included the Giant Sequoia National Monument. While the Giant Sequoia National Monument was ultimately not selected as a monument to reduce or remove, this effort by the administration to reconsider federally protected land indicates that protection "forever" is not certain. Furthermore, while the giant sequoia has survived as it "patiently evolved with the world's slow changes", it must now face climate change (Harvey, 47). As the climate heats up,

many environmental changes impact the sequoia. The snow in the forests melts quickly, causing the snowline to move further upslope, which leads to runoff that doesn't have a chance to absorb into the soil (Harvey, 45). This can lead to drier conditions, which in turn can create larger fires. While reducing carbon emissions may help these trees survive by slowing down climate change, unfortunately, the IUCN has already categorized the giant sequoia as an endangered species (Schmid and Farjon).

These trees are important to conserve. Yet, while giant sequoias may seem to be the major players in their environments, they are only one actor in their ecology. For example, sequoia trees depend on fire, Douglas squirrels, and tiny long-horned beetles to spread their seeds (Harvey, 23). Additionally, "more than 140 insect species" depend on the giant sequoia (Harvey, 23). Furthermore, mycorrhizal fungi serve in mutualistic symbiosis with sequoia roots. Eventually, bacteria and fungi assist in consuming the felled sequoia back into the earth at the end of its life (Harvey, 23; Molina, 78). As an intricate web of species rely on the sequoias, their ecological role is important to acknowledge. A forest without sequoias will certainly impact the other species that work alongside it, as well as the ecology as a whole.

These forests and their species illustrate the workings of different perspectives of time and space, as well as both individual and collective agency in an ecological system. They illustrate the novel ways lives function in this ecology. Yet, they provide more beyond life: as Tsing et al. note, "To track the histories that make

multispecies livability possible, it is not enough to watch lively bodies. Instead, we must wander through landscapes, where assemblages of the dead gather together with the living" (Tsing et al., G5). Sequoias expose what a life of centuries looks like, and what life after centuries can come to be. As they meet their end, sequoias graciously give back to the earth, their fellow species, as well as us. Sequoias are not just resources, carbon sinks, food and shelter- they are species, habitats, ecosystems, and storytellers worth protecting.

2.6 SCIENCE, TECHNOLOGY AND ART ENTWINE

As climate change, ecological destabilization, and biodiversity decline become central factors impacting our futures, communicating the importance of our roles as terraformers is crucial. Perhaps a collaboration between science, technology, and art can help stress the need for various fields to work together to mitigate ecological crises. As Tsing et al. state:

> The rigid segregation of the humanities and natural sciences was an ideology for modern Man's conquest, but it is a poor tool for collaborative survival. Co-species survival requires arts of imagination as much as scientific specifications (Tsing et al., M8).

These collaborations are already appearing in research-creation works. For example, in their article, "Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior"

(2014), Sun Joo (Grace) Ahn, Jeremy N. Bailenson, and Dooyeon Park assert that immersive virtual environments (IVEs) have the ability to influence user's behavior, and in particular, environmental behaviors (235). In one of their experiments, they compare the effects of cutting down a tree in a virtual environment to reading or watching media about the same subject. In their research, they found that those who interacted with the subject matter in the IVE consumed 20% less paper than those who read or watched content on the subject matter (Ahn et al., 235).

Furthermore, in another research paper, "Feel the Burn: Exploring Design Parameters for Effortful Interaction for Educational Games" (2013), Leilah Lyons, Brenda Lopez Silva, Tom Moher, Priscilla Jimenez Pazmino, and Brian Slattery explore the use of "effortful interaction" in educational games to communicate information to users (Lyons et al., 400). Lyons et al. define "effortful interaction" as a form of human-computer interaction where different types of physical interactions are used to communicate information, relying solely on feedback from the user's own body (Lyons et al., 400). In this experimental exhibit, the researchers aimed to demonstrate to users the physical fatigue polar bears experience due to melting sea ice through sensor controllers worn on their head, hands, and feet. Therefore, their research explored the assemblage between creative implementations of embodiment and effortful interaction with technologies such as digital games and sensors, in order to create a pedagogical tool for communicating complex scientific information. As seen through these examples, the alliance between technology and art can provide us with new ways

of seeing, understanding, feeling, and synthesizing scientific research. These entangled fields are further highlighted in speculative design practices.

Anthony Dunne and Fiona Raby's book, *Speculative Everything* (2013) discusses speculative design as a creative theory and method that moves beyond designing products to designing ideas, ranging from designs of the future to conceptual designs that make us think beyond individual technical components. Throughout the book, Dunne and Raby discuss various methods, approaches, and examples of speculative design, while also contextualizing it within different fields, ranging from literary fiction to political science and future studies (Dunne and Raby, 11).

While Dunne and Raby's book focuses on design rather than art, they mention the longstanding relationship between science and art known as SciArt. They describe SciArt as, "sometimes criticized as bad science and bad art, and it can be, but more often it is simply something different, not science and not art" (Dunne and Raby, 51). They go on to describe the role of the artist in this field: they are either artists helping scientists communicate their research, scientists advising artists, or artists that become scientists for the art's sake (Dunne and Raby, 52-55). Yet, while they believe that future scenarios and designs should be "scientifically possible," Dunne and Raby contrast SciArt with the relationship that science and design could have. While SciArt celebrates science by communicating scientific research to the general public, design can instead "facilitate debate and reflection about the social, cultural, and ethical implications of science" (Dunne and Raby, 4, 51- 52). Therefore, Dunne and Raby represent science and design as a more critical

assemblage than science and art. Yet, in *Mother of the Forest*'s case, I believe that communicating scientific information can be critical in its own right—as it is not necessarily focusing exclusively on the testing of hypotheses and reporting of findings, but on illustrating how species and ecologies are changing over time due to anthropogenic causes.

One effective way of communicating scientific information through creative practice is information visualization; examples include Climaps by EMAPS (Venturini); Bloomberg's animated visualizations in "How a Melting Arctic Changes Everything" (Roston, 2017); and Miriam Quick's *Human Impact* infographic for WWF (Quick, 2013). Furthermore, Isabel Meirelle's book *Design for Information* (2013) provides a comprehensive overview of the different types of information visualization principles and methodologies through theoretical, historical, and practical design methods. Meirelles breaks the book down into chapters focusing on different themes of information visualization: hierarchical structures (trees); relational structures (networks); temporal structures (timelines and flows); spatial structures (maps); spatio-temporal structures; and textual structures. Meirelles asserts that the role of information design is to make it easier for designers and scientists to work together, as information design must be able to communicate content in visually comprehensible ways, allowing the viewer to use an analytical and visual approach to understand complex data and information (Meirelles, 7-9).

Overall, the intermingling between science, technology, and art enables *Mother of the Forest* to blend scientific fact and fiction, present and future, real and imaginary worlds. This provides plentiful possibilities to aid public understanding of the science of the sequoia ecosystem while opening up space for a discussion about the role that art and science play in combination with one another. This discussion prompts questions like: what are the affordances and limitations of mixing science, technology and art for environmental advocacy? What techniques provide a new route for enlightened thought, and what is sacrificed when objective truth is fused with subjective beauty? According to science fiction writer Ursula K. LeGuin:

> Science describes accurately from outside; poetry describes accurately from inside. Science explicates; poetry implicates. Both celebrate what they describe. We need the languages of both science and poetry to save us from merely stockpiling endless "information" that fails to inform our ignorance or our irresponsibility (Le Guin, M16).

2.7 SPECULATING NARRATIVES FOR POSSIBLE FUTURES

In order to more fully appreciate the communicative capacity of blending science, technology and art, it's important to recognize how these fields together can be used as a tool for considering the futures of the Anthropocene. Futures studies, or

futurology, is a field for postulating what the future might hold. The methods used in this field range anywhere from foresight and scenario building, to backcasting and analyzing trends. Yet, while futures studies propose different ways to plan for various potential futures, Tsing et al. note that futurist thinking under capitalism tends to forget the species and landscapes we leave behind. Tsing et al. claim, "Anthropogenic landscapes are also haunted by imagined futures. We are willing to turn things into rubble, destroy atmospheres, sell out companion species in exchange for dreamworlds of progress" (Tsing et al., G2).

Yet, I believe it's important to not stay fixed in the past and present of ecological ruin, as it can have a debilitating effect. While it's easy to dwell on our mistakes that came before, I maintain that futurist thinking can help promote an active agency for humans to make planetary change, on both individual and societal levels. While the task may be daunting, I believe practicing the craft of looking in both directions from many sets of perspectives can deliver enough information to plan a future that works for a diverse collection of earthly species. These alternative perspectives of the past, present and future can be crafted and considered through speculative design.

Through the fusion of ecological science, technology, and artistic methods for futurist thinking, a pivotal node emerges to connect these fields together: storytelling. While futures studies frame this creative writing method as science fiction, I prefer an alternative term, "multispecies storytelling" (Haraway, 10). As Dunne and Raby note, science fiction "places a strong emphasis on technological

futures" (Dunne and Raby, 100). In contrast to this, *Mother of the Forest* focuses on the future of species rather than technology. It implements multispecies storytelling to consider the stories of other creatures that oftentimes go unheard or unnoticed by humans. Tsing et al. refer to this practice as "worlding": a "theorizing and storytelling that is rooted in the historical materialities of meetings between humans and nonhumans" (Tsing et al., M23).

This practice of worlding and multispecies storytelling can be seen in current video games. In Melissa Bianchi's article, "Inklings and Tentacled Things: Grasping at Kinship through Video Games" (2017), Bianchi analyzes two games that revolve around cephalopods: *Octodad: Dadliest Catch* (2014) and *Splatoon* (2015). In each of these games, there are visual assemblages between human and octopus. While *Octodad: Dadliest Catch* depicts a narrative where an octopus is trying to blend into a human world, *Splatoon* depicts a more speculative future composed of octopus-human and squid-human evolutions that are in competition with each other. Through these analyses, Bianchi claims that video games are an innovative tool for multispecies relations: their interactive and imaginative structure can employ game aesthetics, play mechanics, and storytelling compositions that create notions of "kinship" between human and other (Bianchi, 141). Bianchi notes that when kinship is considered in game design, games are constructed differently, as there is a shift from humans that "become" machine, to humans, machines, and species "becoming-with" one another (Bianchi, 12-13).

Furthermore, multispecies storytelling can be employed through speculative design methods, specifically speculative fiction, as a means to ponder other species perspectives. While Dunne and Raby focus on design rather than artistic methods, objects rather than digital worlds, and story *making* versus story *telling*, I use Dunne and Raby's speculative frameworks to contextualize my own artistic, digital creation of species' perspectives through speculative fiction. I find their frameworks useful for integrating scientific information with creative writing and artistic practice, as well as futurist thinking. In particular, I produce *what-if* questions (Dunne and Raby, 86). Dunne and Raby assert that, through the use of *what-if* questions, design speculations can help us shape and prepare for our radically changing future, as we move away from narratives to instead speculate ideas. In *Mother of the Forest*, I use *what-if* questions to postulate the perspective of various species and ecologies through different manifestations of time and space. Furthermore, I contemplate how these perspectives can represent the connections between species and their ecological systems. *What if* we could experience the world from the perspective of a Douglas squirrel, mycorrhizal fungi, or sequoia tree? What would that look like, and how might that impact our understanding of an ecology? Through the formulation of these questions, I encourage "multispecies justice" in my work (Heise, 226).

In her 2016 book, *Imagining Extinction: The Cultural Meanings of Endangered Species,* Ursula K. Heise discusses how the stories we share of other than human species shape how we view other species, particularly those who are endangered. Heise claims that biodiversity, endangered species, and extinction are not scientific

issues; rather they are cultural issues that visualize what we value and what stories we choose to broadcast. She claims that the stories we choose to share reflect how we view ourselves as humans, as well as how we view our relationship to other species.

Heise uses the term *multispecies justice* to promote greater advocacy for non-human species. She defines this term as "the kind of project that requires a more-than-human diplomacy – a project that pursues justice with both a sense of cultural differences and a sense of species differences" (Heise, 199). Heise claims that the value we place on specific species matter, and we must acknowledge which species we choose to value, as well as why we value them. Furthermore, she states we must analyze how these species and values change between different cultures. Heise also discusses the role the Anthropocene and speculative fiction play in conservation efforts and multispecies justice. She notes that the Anthropocene can be viewed as a science fiction "trope", as it "casts the present as a future that has already arrived" (Heise, 203). Meanwhile, she considers that many nonfiction environmental works "draw increasingly on themes and narrative strategies of speculative fiction" (Heise, 18). Heise claims that, in order to fulfill multispecies justice, we need to implement techniques such as speculative fiction to plan a world that focuses less on biological factors, and more on technological and political factors, in order to build a future shared between species (Heise, 18). According to Heise, in order to shape futures with other species, the cultural contexts of biodiversity, conservation, and extinction outweigh the scientific contexts, as they

help us understand how these concepts are used to construct a specific stance towards ecological destabilization and advocacy efforts.

Therefore, through an assemblage between futurist thinking, speculative fiction, and multispecies justice, multispecies storytelling can flourish, as it provides new ways to look at the many stories that make up our planetary perspectives. It also demonstrates how all of these connected stories are constantly in flux through the rhythms of time. As Haraway states, "Good stories reach into rich pasts to sustain thick presents to keep the story going for those who come after" (Haraway, 125). These stories are always developing, with new additions, new revisions, and unexpected futures to be taken into consideration. They ask for active and level participation between all pieces of a living system to keep on moving, growing, and thriving into the future.

2.8 SIMILAR CREATIVE WORKS

While my intent for *Mother of the Forest* is to create a novel way to interact with scientific information through storytelling, art and technology, it is not the first of its kind. There have been other interactive media projects that trace other-than-human perspectives, human-animal-plant-machine relations, ecological information visualizations, and environmental speculative fictions.

BBC's *Planet Earth* Nature Documentary Series

One of the most popular forms of environmental communication is documentary film. I've chosen to include BBC's *Planet Earth* (2006) and *Planet Earth II* (2016) as works that are similar to and have also inspired *Mother of the Forest*. *Planet Earth* is considered one of the most popular and expensive nature documentaries ever produced. Each episode is focused on a specific biome, where the audience is introduced to various species in a habitat (Figure 3). The high definition cinematography is paired with voiceover by David Attenborough, who succeeds at combining scientific fact with creative writing to produce an interweaving narrative that assembles the stories of seemingly disparate species into a cohesive world of interconnections. The result is an interesting example of didactic learning for environmental communication. Some of these species are introduced in isolation, while others are shown interacting with their ecosystem.

FIGURE 3. *Planet Earth*: Season 1, Episode 10, "Seasonal Forest". 2006.

Source: "Planet Earth." BBC America,www.bbcamerica.com/shows/planet-earth/season-1/episode-10-seasonal-forest. Accessed 7 Jan. 2019.

Yet, *Planet Earth* has been critiqued for not contextualizing these habitats with the ecological destabilization that is occurring in the rest of the world. In his article, "The BBC's Planet Earth II did not help the natural world", Martin Hughes-Games discusses the ecological implications of *Planet Earth II*, despite the *Planet Earth II* producers' insistence that the show aims to get its audiences to care about the natural world. Hughes-Games states:

> The producers continue to go to the rapidly shrinking parks and
> reserves to make their films – creating a beautiful, beguiling fantasy
> world, a utopia where tigers still roam free and untroubled, where
> the natural world exists as if man had never been (Hughes-Games).

In addition to the potential illusions Planet Earth constructs for viewers, I wonder what the implications are for physically filming in these habitats. Does the proximity of humans and/or machines impact these ecosystems? What about the rippling effects of transporting everything that goes into the production of Planet Earth? Does Planet Earth's spotlight on these habitats have the opposite effect that the producers intend, where rather than preserving these biomes, they are instead targeted as tourist destinations? While Planet Earth hooks audiences into the stories and lives of other species through footage of these physical biomes, it could potentially be adding to the biodiversity decline of the Anthropocene. While *Mother of the Forest* also implements film footage of specific locations in the sequoia forests, perhaps its greater use of digital, animated representations can

help preserve and conserve these ecosystems by decreasing the intrusion of humans and equipment on these natural areas.

David OReilly's *Everything* (2017)

Another creative work that has influenced *Mother of the Forest* is David OReilly's digital game, *Everything* (2017) (Figure 4). *Everything* is an interactive game that simulates the connection between all things. The user is able to be all sorts of things in the world, creating a literal visualization of "becoming-with". As users change from living species to geographies, atoms to galaxies, they can experience the perspective of various forms of matter at different scales. *Everything* truly succeeds in its sound production, as the experience is narrated using clips from philosopher Alan Watts, allowing the playful interaction of becoming everything in this world to flow with philosophical themes of shared existence, entanglements, and kinship that shine throughout the experience. While *Mother of the Forest* also uses a shift between different species' perspectives and scales, as well as the implementation of voiceover, it is more grounded in communicating scientific facts and concepts, thereby creating a clear connection between different species of a particular ecological niche.

FIGURE 4. OReilly, David. *Everything*. 2017.

Marshmallow Laser Feast's *Treehugger* (2017) & *In the Eyes of the Animal* (2015)

Production studio Marshmallow Laser Feast (MLF) explores the coupling of striking visuals with unique sensory experiences that can also be connected to themes of "becoming-with". In their immersive experience *Treehugger* (2017), an installation that is one-part virtual reality, one-part physical set, the user can hold onto a foam piece that is shaped like a tree, and lean into the trunk of a giant sequoia as they become a water particle in virtual reality, floating up the trunk of the tree. MLF also incorporate scientific information into this installation, as the

tree is visualized by vibrant, moving particles that depict actual data collected from the trees, from their volume to their biosignals (Figure 5).

Therefore, Mother of the Forest shares similarities to MLF's *Treehugger*, from the use of virtual reality to their subject matter of a sequoia tree. However, their use of scientific information is quite different – while *Mother of the Forest* uses scientific data to create a narrative and visualize the terrain, *Treehugger* uses data to visualize various components measured from the trees themselves. Additionally, *Treehugger* uses a physical set to have users move into the tree as a water particle with stylized visuals, whereas *Mother of the Forest* relies only on a virtual reality headset to jump between different species' perspectives, which are visualized in various ways.

FIGURE 5. Marshmallow Laser Feast. *Treehugger*. 2017.

Source: Holmes, Kevin. "Give a Giant Sequoia Tree a Hug in Virtual Reality." *Vice*, 20 Dec. 2016, www.vice.com/en_au/article/wnpvjq/hug-giant-sequoia-tree-virtual-reality. Accessed 10 Jan. 2019.

Marshmallow Laser Feast also created another immersive interactive piece, *In the Eyes of the Animal* (2015). This virtual reality installation lets viewers see from the perspective of different creatures (mosquito, dragonfly, frog, and owl) within a forest, as they experience the perspectives that make up this ecology (Figure 6). Users can experience the piece online, or they can go to a physical location in a forest where virtual reality headsets are on hand. When present at the installation site, users wear a large orb on their head, as well as a SubPac that produces vibrations to create a greater sense of immersion in this forest. These visuals also incorporated information, as MLF used Lidar scans and 360 cameras to capture volumetric data of the environment. Physical pieces of the forest were additionally used to make custom headsets that hang from the trees in the forest, while 3D audio samples from forests were used for spatialized audio.

In the Eyes of the Animal feels like the most closely related piece to *Mother of the Forest*, from its use of virtual reality and spatialized audio samples from the forest, to its emphasis on different species' perspectives. However, the two diverge in several important ways. While *In the Eyes of the Animal* visualizes species' perspectives using various colored dots and movements, as well as a SubPac, *Mother of the Forest* uses a more realistic visualization from a human's perspective. Rather than using volumetric data, it uses magical realism to emphasize differences in perspective through changes in time, lighting, scale, space, and movement. Additionally, *Mother of the Forest* is only available on a computer.

However, I would love to imagine it placed within the depths of the sequoia forest – a future endeavor I hope to integrate later.
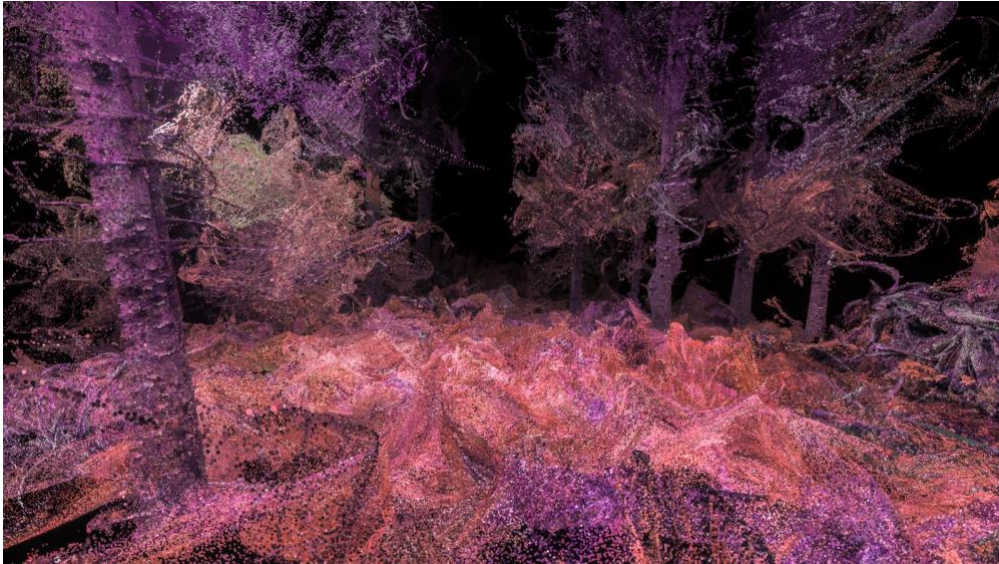
FIGURE 6. Marshmallow Laser Feast. *In the Eyes of the Animal*. 2015.

Source: "In the Eyes of the Animal Screens_09." *Creative Applications Network*, 23 Sept. 2015, www.creativeapplications.net/maxmsp/in-the-eyes-of-the-animal-mlf-virtualise-a-forest-through-the-eyes-of-its-creatures/attachment/in-the-eyes-of-the-animal-screens_09/. Accessed 7 Jan. 2019.

Milica Zec and Winslow Porter's *Tree* (2017)

Another creative work that couples virtual reality with additional sensory effects is Milica Zec and Winslow Porter's immersive experience, *Tree* (2017) (Figure 7). In this experience, the user begins by planting a seed in soil. Next, they wear a Subpac vest and a virtual reality headset to become a tree in the rainforest. As their body becomes a trunk, and their arms become branches, the user experiences a tree's

life, beginning life as a seedling and ending in its final days. When leaving the experience, the user is given a seed to take home. *Tree* shows how a successful pairing between experiential learning and a species' perspective can illustrate the effects of the Anthropocene.

It is slightly difficult for me to compare *Tree* with *Mother of the Forest*, as I haven't had the opportunity to experience this piece. This is perhaps one of the greatest drawbacks to virtual reality experiences, particularly those that are situated as installations. Virtual reality can be difficult for many people to experience, as it is expensive and relies on high-end specs that are not included in many consumer's computers. This lack of accessibility is exacerbated by experiences that are framed as installations, which are only available on particular dates in specific locations. However, from the research I gathered, *Tree* and *Mother of the Forest* share many similarities, as they use virtual reality to become a tree that is impacted by human activity and lives a precarious life. However, *Tree* is more poetic in its creation, leaning on emotional values, while *Mother of the Forest* relies more on scientific information as an educational, communication tool. I hope to one day experience *Tree*, and have the opportunity to visit a digital experience that leaves me with a physical seed to carry home with me.

FIGURE 7. Zec, Milica and Winslow Porter. *Tree*. 2017.

Source: "Tree." *Communication Arts*, www.commarts.com/project/26376/tree. Accessed 10 Jan.

2019.

2.9 *Mother of the Forest*'s Role

Through the blend of digital ecosystems, species' perceptions, scientific information, speculative design, future studies, and storytelling, *Mother of the Forest* distinguishes itself as an "art science activism" that relies on the strengths of objective scientific research with subjective poetic creations to illustrate a world that could, in fact, be situated in our present reality, yet hidden due to our limited human perspective (Haraway, M25). *Mother of the Forest* creates a connection between the history of these forests, their current state, and their unknown futures, to consider how diverse species impact a space as it moves into the future.

Fiona Stafford notes that while "screens make virtual access to the natural world ever easier, it seems that people become more and more determined to see, smell and touch the real thing" (Stafford, 17). In this regard, *Mother of the Forest* works to promote ecological advocacy in two ways: it provides a mere trace of these sequestered forests, inviting the user to go experience the physical forest for themselves; and through interactive storytelling it provides a rich avenue to learn in depth about the forest's intricacies, even when the user stands at a vast distance from the California forest's physical location. *Mother of the Forest* asks the user to transcend the limits of their own individual perception, to experience other scales of space and time foreign to them. This allows users to contemplate the past ecological histories and perspectives that have led to our present, while sensing an overarching theme of the struggle for a more habitable future. Through speculative fabulation, perhaps *Mother of the Forest* can illustrate the complex webs of a sequoia forest that needs us, just as much as we need it.

METHODOLOGY & CREATIVE PROCESS

As I began planning the details of what would later become *Mother of the Forest*, I was unsure what my approach to environmental communication would be. I wanted to focus on the environment, but I was unsure which case study to use. I knew I wanted to create something that would communicate information about the environment, but I was unsure of what medium. I also knew I wanted to choose a topic that resonated for me personally.

I decided to stick close to my previous craft, while also pushing the boundaries of my comfort zone and trying something new. With a background in film and animation, storytelling is a technique that I've had experience with, but it's also a skill that I want to further develop. I have encountered many variations of stories about humans, by humans, and for humans. Yet, as I came across the idea of multispecies storytelling, my previous understanding of what storytelling could be changed. I was familiar with stories laden with anthropocentrism and anthropomorphism, from stories where pets could talk, to animations that used other-than-human characters to tell clearly human stories. Yet, I hadn't considered the stories of other species, and how they might experience our present moment in

ways both similar and dissimilar to our own. Storytelling was always a human practice to me. Yet, this was a new form of storytelling. Storytelling that could be made about humans and others, with humans and others. I became aware of all the perspectives missing from human stories, as well as those hidden from my limited, human perspective.

My other practiced craft is creating animated worlds. I can breathe life into colored pixels on a screen. Yet, my previous animated worlds were highly orchestrated affairs. I decide the angle, the lighting, the backdrop, and the subjects. While I brought this familiarity with animation production to the table, I knew that I wanted to create more than a rigidly choreographed set. I wanted to create a world, a habitat that could be explored. This felt the most appropriate for environmental communication, to focus on experiencing an ecology rather than watching a character on a set. In order to incorporate experiential learning, I decided to create an interactive, immersive environment.

I then considered the various subjects that I could explore. Who else might have a story to tell? What might those stories be? Who is implicated in these stories? Am I? Who else creates worlds? What world are they in? Do they make their own worlds, or worlds for others? My thoughts turned to the important stages of my life, where I was wrapped up in other species' lives.

My dogs have occupied such an important place in my life. I know their lives backwards and forwards from my perspective, but certainly not theirs. Yet, their

modern lives as pets feel pretty close to mine. Ultimately their place in my life, though personally significant, did not provide me with a suitable outlet for environmental communication. Another species I look forward to encountering in my daily life is the raccoon that sits outside my house in my trashcan, arms uplifted in anticipation of my week-old leftovers. I'm sure he would have some stories to tell, but not the story I want to tell right now. I wanted a character that wasn't completely shaped by human civilization and progress. I was also in search of more than one character. I wanted a landscape. This led me to think of the sense of place. I thought of various places that bring me comfort—my homes: where I was born, where I grew up, where I was alongside my favorite people, where I am now, and where I hope to be in the future. I associate all of these places with particular geographies and elements. I realized, that despite the vast distances between these places, the different cultures, different people, and different experiences, all of these places have two things in common: they have me, and they have trees.

I realize that I have many stories that include trees, yet I also realize that I might be a part of their story. In both a scientific and poetic sense, trees are storytellers. We are storytellers together, co-telling and archiving the histories of our world.

We are also world makers. While I create imaginary worlds using technology, I am also a physical world maker. I am a terraformer, shaping the Earth every day with my consumption, travels, and experiences. I make worlds for myself, and unintentionally, I make worlds for others. Trees also make worlds, for themselves, but also for others.

Therefore, in order to continue in the spirit of world making alongside trees, I wanted to create *Mother of the Forest* using an analogous methodology. In order to construct this research-creation,[8] I relied on Donna Haraway's transdisciplinary theory and technique, speculative fabulation, as my methodology. I chose speculative fabulation for its combination of science and art, research and speculation, histories and futures, truth and beauty. Speculative fabulation permits me to use didactic and experiential learning methods within environmental communication, shifting the focus of storytelling away from human-centered worlds and histories, to focus instead on stories of worlds created through collaboration.

3.1 SPECULATIVE FABULATION

Developed by Donna Haraway, speculative fabulation falls under the SF signifier that defines her work: "science fiction, speculative fabulation, string figures, speculative feminism, science fact, so far" (Haraway, 2). It is a collaboration between science and art, history and future, facts and fiction. Haraway defines SF as, "storytelling and fact telling; it is the patterning of possible worlds and possible times, material-semiotic worlds, gone, here, and yet to come"; a "tight coupling of writing and research—where both terms require the factual, fictional, and

[8] According to Owen Chapman and Kim Sawchuk of Concordia University, research-creation projects "typically integrate a creative process, experimental aesthetic component, or an artistic work as an integral part of a study" (Chapman and Sawchuk, 6).

fabulated; where both terms are materialized in fiction and scholarship" (Haraway, "SF: Science Fiction, Speculative Fabulation, String Figures, So Far", 31). This union between dichotomous fields facilitates the use of more philosophical or abstract theories such as becoming-with, entanglements, and kinship. These become tangible goals for a research-creation practice aimed at multispecies justice and environmental communication, as art and science embrace each other's flaws to become something potentially stronger, or in the very least, something rather distinctive.

Speculation often appears in two forms: speculating the future (projections and hypotheses of the future); and speculating the imaginary (the other, the could have been, the could be). When looking up the term, I was inundated by journal articles that linked the keyword "speculation" to "oil futures" and "oil markets", which gives a glimpse of where this term is often used, in economics and capitalism. Instead, the speculation in speculative fabulation comes from speculative fiction or futures studies. It entails the philosophical observation of both the future and the many possibilities that abound from our present and future. My speculations for *Mother of the Forest* include: how do our limited perspectives shape how we view the world? What do other species perspectives look like? What could an imagining of their perspective bring to the table for ecological science and environmental communication? This speculation hints at possible worlds and stories that were always present in reality, but have gone unnoticed.

Meanwhile, fabulation is the creation and making portion of this methodology. According to Haraway, to fabulate is "the everyday storytelling practice of storytellers", the practice of creating fables, the practice of producing art ("Donna Haraway / Speculative Fabulation"). The fabulating of speculative fabulation speaks to the possible futures we discover, and how to transform them into stories and worlds. One method of fabulation is Tsing's notion of "worlding" mentioned previously (Tsing et al., M23). Haraway also calls speculative fabulations "art-science activisms" (Tsing et al., M23). Therefore, this method includes species collaborations that come together to create both empirical and invented worlds.

Together, these two concepts provide the building blocks for combining conceptual theories of entangled lives across the future with creative practices that produce artifacts to explore. As Haraway repeats throughout her work:

> It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories (Haraway, 12).

Haraway demonstrates speculative fabulation in practice with her description of a speculative writing workshop she participated in with filmmaker Fabrizio Terranova and philosopher Vinciane Despret. In the workshop, groups were asked to write about a baby through five generations. Through their shared efforts, they

produced "The Camille Stories: Children of Compost" (Haraway, 134). This collaborative storytelling between a scholar, a filmmaker, and a philosopher tells the tales of five Camilles from 2025 to 2425, where human populations fluctuate, symbioses between humans and other species flourish (in Camilles' case, Monarch butterflies), and humans learn to become-with their fellow planet inhabitants.

Another example of speculative fabulation can be found in Juan Francisco Salazar's chapter, "Speculative fabulation: Researching worlds to come in Antarctica". In this piece, Salazar discusses his use of speculative fabulation with ethnographic research to study and speculate anthropological futures. He explores Antarctica's shift from a desolate wilderness to an increasingly inhabited world. As he discusses how climate change and human activity are currently impacting the Antarctic region and its species, Salazar combines science with futurist thinking through the creation of his speculative documentary film, *Nightfall on Gaia* (2015). Salazar notes that Antarctica thus becomes a stomping ground for speculation, "not only as a laboratory for science, but as a laboratory for thinking alternative ways of living in the Anthropocene" (Salazar, 152).

In order to speculate futures in Antarctica, Salazar combined ethnography with documentary film. *Nightfall on Gaia* is set in the year 2043, with flashbacks to past Antarctica (2012-2014) used throughout the film. The film asks viewers to speculate a future where Antarctica's ice is vanishing. Salazar notes that through the creation of this project, he "[drew] on Donna Haraway's ambivalent and ambiguous notion of 'speculative fabulation'... to argue that in coupling arts

practice and cultural research through 'material-semiotic entanglements' of the factual, the fictional, and the fabulated, both the filmic and the ethnographic become correlated to interact with each to enact a realism of the possible" (Salazar, 154).

Furthermore, Salazar references geographer Ben Anderson's three "anticipatory practices": "calculating futures"; "imagining futures"; and "performing futures" (Salazar, 155). While many believe documentary is about presenting the "actuality" of the past and present, Salazar argues that documentary film can extend to include the "possibility" of potential futures or alternative worlds (Salazar, 163).

These practices have shaped my own creative practice as I began *Mother of the Forest*. Following Ben Anderson's practices, through scientific research and expert interviews, I calculate futures. Through speculation, creative writing, and entwined stories, I imagine futures. Through fabulating embodied, interactive explorations of other species perspectives, I perform futures. Each perspective gives a story, a partial glimpse of the world. When these glimpses are integrated, they produce realms of different times, spaces, experiences, and feelings. As I create *Mother of the Forest*, this patchwork of stories and worlding practices can help promote holistic understandings of ecologies, natures, and worlds.

In the next section, I discuss my creative process through the following sub-sections: expert interviews; pre-production: speculative fiction and scientific information; 360 film production; interactive media production; virtual reality

production; and soundscapes of sequoias. I conclude this chapter by discussing my techniques for weaving all of these creative practices together.

3.2 CREATIVE PROCESS

3.2.1 EXPERT INTERVIEWS

The first step in my creative process was collecting scientific information to communicate and visualize the sequoia forest and its precarity due to climate change. Yet, being an artist who strives to communicate scientific information, while not possessing any scientific expertise, can be a daunting task. Although there is plenty of information I could collect about sequoia ecosystems online, standing in a forest provides a different kind of information to explore and get lost in. As I strove to implement experiential learning methods into my project, it was important for me to experience this place. Instead of researching the forest from afar through a screen, I wanted to physically get lost in it. I wanted to become with this forest, to become entangled in it. While I was already collecting secondary research from scientific studies, I wanted to conduct my own primary research, to speak with people studying, researching, and working with sequoia trees. I wanted the opportunity to ask park officials questions that related directly to my project, and to ask them about their current endeavors. This initial step felt crucial for the life of this project.

I began by reaching out to park experts in the Sequoia and Kings Canyon National Parks. I contacted the Sequoia Parks Conservancy to inquire if there were any individuals available for me to interview. I was put in contact with two individuals: Krista Matias, the programs and volunteer coordinator for Sequoia Parks Conservancy, as well as Dr. Christy Brigham, the chief of resources management and science for the Sequoia and Kings Canyon National Parks. After receiving REB approval, scheduling interviews, and planning a guided tour through the park, I travelled out to Sequoia and Kings Canyon National Parks in California during November 2018 (Figure 8).
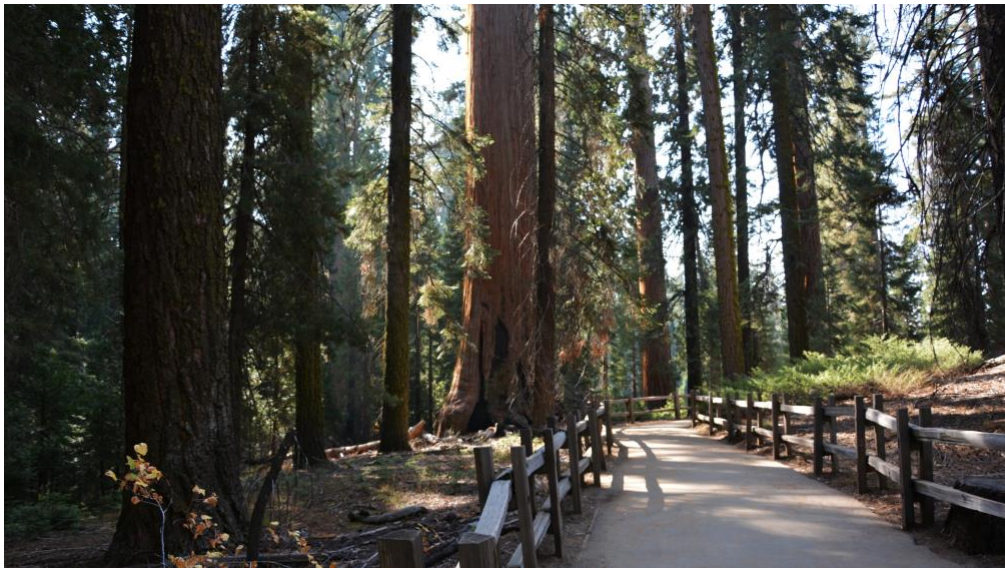
FIGURE 8. Grant Grove in Kings Canyon National Park.

My first interview took place over the course of a daylong hike with Krista Matias (Figure 9). We trekked through various sections of Sequoia and Kings Canyon National Parks, including General Grant Grove, Redwood Mountain Grove, as well as Lost Grove. As we carried the 360-degree film camera and audio recorder

around the forest, hiding behind colossal trees to avoid being seen in 360 film footage, and standing silently to record and listen to the sounds of forest creatures, I asked Krista about the park, the sequoia trees, their ecosystem, her role in the Sequoia Parks Conservancy, and her stance on the future of these forests.

FIGURE 9. Krista Matias speaking about Sequoia National Park.

Krista provided me a great deal of information about the sequoia groves, ranging from their history on earth, to the changes in their lives today as they are surrounded by human civilization, to the potential futures of the forest. One important topic of discussion was the impact of climate change on this region, and whether this ecosystem is experiencing biodiversity decline. Krista noted the

importance of California as a biodiverse region, stating that "just here in Sequoia and Kings Canyon National Parks we have 317 different wildlife species and over 1500 plant species, so there is a great diversity of organisms here supporting sequoia ecosystems" (Matias). Krista continued by listing some of the critters entangled with sequoia trees today, from Douglas squirrels that munch on sequoia cones, bats which roost inside sequoia trunks, and mycorrhizal fungi that are literally entwined in the roots of sequoias. Additionally, other fungi and bacteria break down the tree at the end of its life and return its nutrients back to the earth. All of these species depict symbiotic relationships in one way or another with sequoia trees, entangling their lives together in collective "worlding". Yet, Krista explained that these ecosystems are impacted by climate change.

I also interviewed Dr. Christy Brigham, the chief of resources management and science for the Sequoia and Kings Canyon National Parks. We met for breakfast at a local coffee shop that was on the way to the Giant Forest Museum. During our meeting, we discussed some of the broader subjects surrounding humanity's impact on the environment, along with more scientific discussions of how these sequoia ecosystems operate, how they are impacted by climate change, and the difficulties we (humans) face as we plan for the future, which due to Anthropogenic climate change, entails a potential future of loss. This reminded me of the Cthulucene: learning to live and die, by and with one another.

As I look back on what an amazing experience this was: climbing through the forest, listening for creatures' echoes through the canyon, disappearing from human

development, climbing inside a sequoia tree, embracing a sequoia with a hug goodbye, I realize that this is such a mysterious, beautiful place. I want to share this place with our future.

In this journey, I had made a friend. I made many friends–the little Douglas squirrel, the woodpecker, the many sequoia giants, Krista and Dr. Brigham. I could have stayed in that forest forever. While I will admit that I had previously experienced many instances of doubt during the preparation and planning for this project, this excursion reiterated to me why I was here, and what was truly important in this project, in this place, and in my life. This place is worth protecting. This is our home. These are our kin. This is someone's future. We need to work together in symbiosis to keep these stories, this world, thriving. It reminds me of a popular proverb: *"We do not inherit the earth from our ancestors; we borrow it from our children"*. [9]

3.2.2 PRE-PRODUCTION: SPECULATIVE FICTION & SCIENTIFIC INFORMATION

When I began this project, I knew I wanted to include different species from the assorted kingdoms of life: bacteria, protista, fungi, plantae, and animalia. I wanted to tell the story of an ecology, not of a particular species in isolation. I oftentimes feel like, as animals, humans tend to focus on our own kind, or those most like us (other animals, particularly mammals). Instead, I wanted to include perspectives

[9] For an extended version of my interview results, see Appendix B: Interview Details

that aren't particularly commonplace in mainstream media. Yet, I also knew that including one example from each kingdom would be too ambitious for this narrative, as well as too textbook perfect. I didn't want to check all the boxes and divide it neatly. I wanted it to be natural and messy, like a forest. I also wanted to keep an eye on the scope of the project. Therefore, I decided to choose perspectives that I personally encountered while hiking through the sequoia forest. This resulted in the following cast of characters: a human, a Douglas squirrel (Figure 10), mycorrhizal fungi (Figure 11), and a sequoia tree (Figure 12).
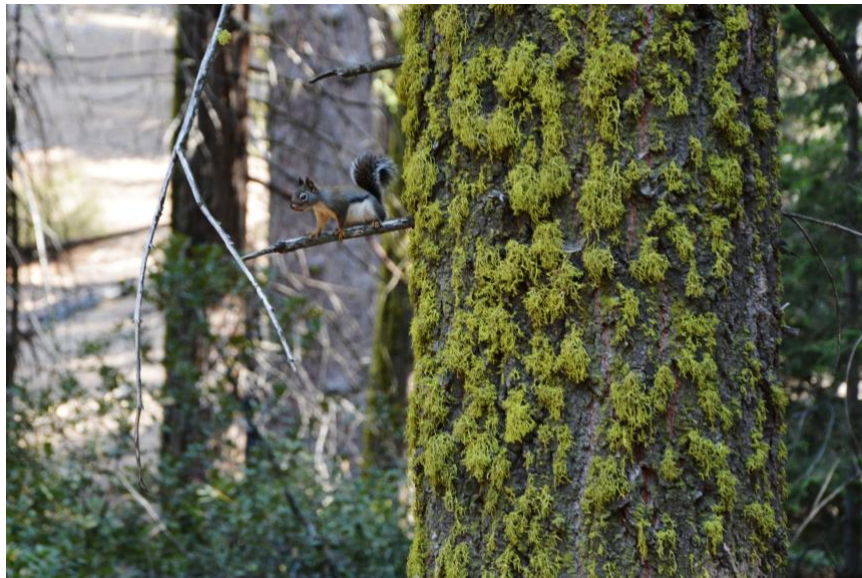

FIGURE 10. Douglas squirrel barking at visitors in Sequoia National Park.

FIGURE 11. Mycorrhizal fungi in Lost Grove.

FIGURE 12. Sequoia tree in General Grant Grove.

The first task in my creative practice was to develop a script and storyboard. Coming from a background in film and animation, I've learned that this first step is the most fruitful way for me to get my ideas recorded, find the flow, and make connections between different stories and worlds. I began this process by brainstorming the following question: how do humans, squirrels, fungi, and sequoia trees make history? What are their stories? How are they different, and how are they the same? How are they connected to each other, and what happens when one vanishes?

With these inquiries in mind, I began a rough storyboard, teasing out how to change between different stories and worlds through the creation of flow charts. While I toyed with shifting perspectives between species based on their scale, their space, or their sense of time, I finally accomplished the right flow when I focused on the already present interactions of different species through a tree's lifetime: human, to squirrel, to fungi, to tree (Figure 13). It's like science had written the story for me. I chose to begin the story as a human in order to introduce the user to the immersive environment, as well as provide history, context and agency to humanity's impacts on these ecologies. This became the introductory, didactic moment to introduce the contextual information of the sequoia forest. Next, came the experiential section of this creation. The narrative would shift from a human's perspective to a Douglas squirrel's perspective, beginning the journey through a sequoia tree's life. [10] Next, the perspective would shift to mycorrhizal fungi,[11] and

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[10] Douglas squirrels eat sequoia cones. This can lead to a dispersal of their seeds and a hopeful beginning to a sequoia's life.

[11] Mycorrhizal fungi help sequoias grow and stay healthy by providing nutrients to the tree's roots.

then finally to the mature sequoia tree itself. At this point, I moved away from a tree's timeline to show the ecology as a holistic, systemic whole. I wanted to illustrate the collective, rather than jump between individual perspectives. To do this, I shifted the perspective to a macro, landscape level, similar to a God's eye view. This shift felt like it would embody the spirit of a holobiont and holism: a living thing (ecology, or Gaia) with situated communities within. After illustrating the ecosystem, the user would then return to the tree's perspective, to see the end of its life. The experience would finally come to a close, with the last change in perspective returning to the human in the sequoia forest, closing on another didactic, yet more philosophical conclusion.
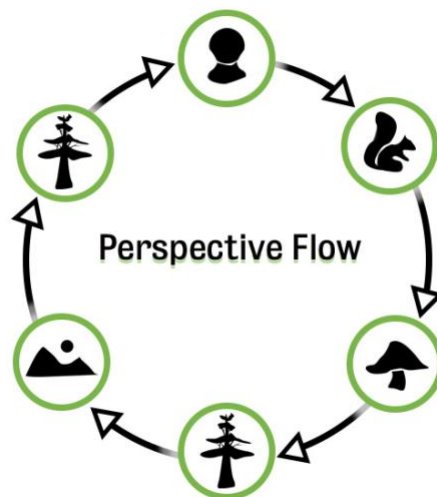

Figure 13. Perspective flow chart.

Illustrates flow of experience based on species' perspectives.

This movement through the experience allowed for a cyclical experience, as the user shifts from their own perspective to other perspectives of scale, space, and time, before finally returning to their original state as human. The cycle through

different perspectives based on a tree's life felt natural, as it complimented a progression through time, while simultaneously matching many natural cycles in the environment.

My next step was to flesh out the informative and interactive elements in each scene. Yet, for me to decide on the proper interactions, I needed to have a script to follow. At this point, I divided the script into two sections: scientific fact and speculative fiction.

I began the script-writing process by dividing each perspective into scenes. Next, I spent weeks collecting scientific research, transcribing my interviews, and placing scientific facts within each scene. This was a bit of a tedious process, as many facts became tied to other pieces. Dividing them out was not as easy as I had hoped. From each fact, various pathways emerged. While I originally believed that dividing these pieces up individually would be easier than creating connections, it came to be the reverse: everything was connected to everything. Regardless, I continued to sift and place all of the research into the various sections. I began looking for stories and information to visualize. While I knew there would be moments of didactic explanations, I didn't want the experience to be inundated with scientific facts. Like Dr. Brigham mentioned during our interview, blaring out facts to the user throughout the entire experience probably wouldn't accomplish what I wanted. As I continued to select information to highlight, and information that could be embedded in the interactions, I began looking for the most obvious connections between species: how is this entangled in others? What effect does this

have on the ecosystem? What would happen if this disappeared? I kept returning to this theme of entanglement and reverberating effects, as I edited and condensed the scientific facts of the story.

Once I selected the scientific information I would visualize, I began to use speculative fiction as an outlet to creatively weave these facts and visuals together into a coherent story. I used speculation to consider both the future, as well as the other. Exploratory questions included: what does the perspective of a squirrel / fungi / sequoia tree / ecology look like? What if we could see their worlds? How can I represent them and their stories? How can we become-with these species, help users see that they are their kin? What is the future of the forest?

Speculating the future was a fairly predictable task. I wanted to focus on the big trends, the big climatic reports coming from sources such as IPCC and WWF, as well as the small effects that would swell from this climate change tidal wave. I followed climate projections, considered what the impacts of biodiversity decline would be to this region, I reflected on what was said in my interviews, and I read other anthropocentric speculations and fictions. While speculating the future is an important part of my project, ultimately this question is left open-ended at the end of *Mother of the Forest* – I didn't feel a need to answer, because I don't know what the future holds. As Dr. Brigham mentioned, humans are pretty terrible at forecasting the future. But if we are to believe science, it doesn't look pretty. I think a term Anna Tsing uses, *precarity*, "life without the promise of stability" describes

the foresight of the future (Tsing, 2). This precarious future became an open-ended question that I hand off to the user to walk away with.

On the other hand, it was my job to really dive into speculating the other, to envision various species' perspectives. While considering the scale and space of each species seemed fairly straightforward, I also decided to experiment with different perceptions of time. As indicated through Healy et al.'s study of species' perception of temporal information, I wanted to explore what time would be for a Douglas Squirrel, mycorrhizal fungi, a sequoia tree, a living ecology. I felt that this might give us a sense of how they experience changes in their climate and ecology.

For the time perception of a Douglas Squirrel, I followed the article and extrapolated that time would move a bit slower for squirrels than it does for humans. Yet, I wondered how we could apply these scientific findings to other species, particularly plants and fungi? For example, how would we measure the perception of time for a tree, when they possess no eyes to test their "temporal resolution"? Could we instead measure their perception of time through how they send and receive information to themselves, fellow trees and other species? According to author and forester Peter Wohlleben, trees send information through electrical signals. However, unlike humans, "the signal is not transmitted in milliseconds"; rather, the signal "travels at the slow speed of a third of an inch per minute" through their own bodies, and "a third of an inch per second" to communicate with other trees through their roots and fungal networks (Wohlleben, 8). Additionally, plants respond to cyclical notions of time, from circadian rhythms

causing some plants to open in the day and close at night, to transformations in plants from season to season. Furthermore, sequoia trees are known for their immense body masses (the largest sequoia tree, General Sherman, has a trunk volume of 52,508 cubic feet) (Harvey, 11). If, using Healy et al.'s article, we speculate that a sequoia's large mass and slow communication results in a low "temporal resolution", could we consider that this tree's sense of time, even over a lifetime of thousands of years, would look like a swift passage of time in our eyes?

While in *Mother of the Forest* this passage of time would be visualized like time-lapse photography to experience time as a sequoia tree, this shift in time scales is also about experiencing the concept of deep time, a time period that lasts longer than human lifetimes. This conversion from our time, to sequoia time, to ecological time, can exemplify how, over a long period of time, things seem to change rapidly. This ties directly into the *shifting baseline syndrome* concept to show how we might not notice changes that have happened slowly or over extensive time scales, because we forget things in our own lifetime, and we are unable to experience what things were like before our lives. Therefore, this adjustment of the rate of time became both a helpful transition tool to move between the sequoia tree and ecology perspectives, as well as an important concept to illustrate.

I continued to speculate the various species perspectives. How do they "see", and what do they see? What is their routine, day in and out? What do their interactions with other species look like? How do they perceive or notice the changes around them? How are their stories connected to sequoias?

While creating these species perceptions, I became concerned that I would fall into the trap of anthropomorphism or anthropocentrism. In response, I persistently attempted to embody other species as completely devoid of human traits. No emotions, no sadness, no first-person voiceover, no expression, just scientific facts. Yet, something felt cold and isolating. I was distancing myself, as I attempted to become as objective as possible. This left a feeling of absence. While there is no doubt a sliding scale to anthropomorphism and anthropocentrism (I wasn't going to create talking squirrels, trees, or mushrooms), I realized that I could not escape some human traits trickling into this process. I, the human that is creating this artwork, am inherently wrapped up in this creative process. Over time, I realized that my subjectivity would emanate throughout this experience, because it's my thoughts, my efforts that have pushed this project along. Precarity comes up again, "the condition of being vulnerable to others" (Tsing, 20). I think this is what it means to *become-with*, or at least for me. I am learning how to feel empathy and consider other species, but I am also wrapped up in the empathy I feel, and the actions that result. As I attempt to become with these species, I can learn things beyond my human form, but I can't entirely let go of my humanity either. This quote from political theorist Jane Bennett about anthropomorphism exudes the importance of what I learned through this process, to not stray away from my own experiences:

> Are there more everyday tactics for cultivating an ability to discern the
> vitality of matter? One might be to allow oneself, as did Charles Darwin, to

anthropomorphize, to relax into resemblances discerned across ontological divides: you (mis)take the wind outside at night for your father's wheezy breathing in the next room; you get up too fast and see stars; a plastic topographical map reminds you of the veins on the back of your hand; the rhythm of the cicada's reminds you of the wailing of an infant… (Bennett, 119-120).

I think this is what speculative fabulation is about. Producing science, facts, something based in reality, but implementing creative writing and personal experience to give life and voice and connections to these stories. This is *becoming-with*. Learning that, for all of our differences, for the way we perceive things differently, we are still alike. We are kin. Earth is all our home.

In the end, I created a script that was a mixture of scientific research, speculative fiction, information visualizations, future studies, and my own personal experience.[12] My next step in this journey was to ground this creative endeavor in the sequoia forest. I decided to introduce the user to this ecosystem through immersive, 360 footage of the forest.

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[12] See Appendix A: Script

3.2.3 360 FILM PRODUCTION

My first step in creating *Mother of the Forest* involved creating immersive environments through 360 film. This enabled me to introduce the user to the immersive experience by allowing them to see the specific, physical forest in California. The first 360 video I created was entirely digital. [13] Rather than dropping the user straight into a forest and inundating them with facts about the national parks, I wanted to begin the experience by providing a moment to stop, listen, and contemplate. Neither information heavy nor interactive,[14] this is the introduction to immersion. In this scene, I wanted to familiarize the user with the species of this story by providing an initial glimpse of them. I also wanted to visualize the concept of entanglement. To do this, each species is composed of small trails that crawl along their surface. As the contours of the species take shape, they quickly stretch out to become a ball of tangles, later reorganizing into a new species. This evolution from species to species illustrates that we are all connected, all species borrowing time from Earth, entangled in one another. The visual is abstract, yet it helps set a tone and theme that runs throughout the experience. To help clarify the visual, brief outlines of each species illuminate in front of their entanglements (Figure 14).

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[13] This 360 video was produced using Cinema 4D, Adobe Premiere, and Adobe After Effects.

[14] While I believe interactive can include looking around the immersive piece with a headset, I am using interactive here to describe using controllers and giving users agency to progress the story.
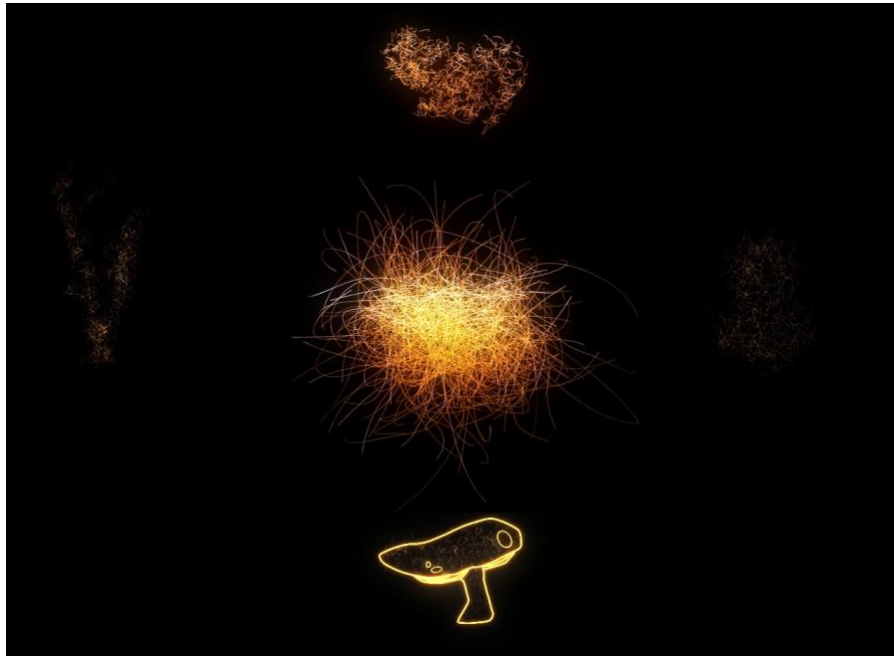
FIGURE 14. 360 digital video of entanglements. In this figure, various animated entanglements are exhibited, from long to short trails, to species outlines.

My next 360 footage production was more conventional, as I used recorded footage to introduce the user to the sequoia forests. While hiking with Krista in Sequoia and Kings Canyon National Parks, I recorded different areas of the park using a 360 camera (Figure 15). I decided to use this footage as bookends to the experience. Each piece of footage embodies a sense of scientific objectivity, as they become archives of the physical forest in California. I felt that this setting would give me an opportunity to tell users about the forest before diving into the digital representations, speculative perspectives, and interactive elements. I also felt like this would be an appropriate medium to close the experience with, to have users walk away from an archive of a physical location, rather than a digital representation. A cyclical flow was appearing again through this creation.

FIGURE 15. Setting up the 360 camera in Sequoia National Park.

While I recorded hours of footage over my four-day trip, I narrowed the shots used in *Mother of the Forest* to the following locations: Grant Grove, Redwood Mountain Grove, Lost Grove, Big Stump Trail and an overlook from Generals Highway in Sequoia National Park (Figure 16). The first collection of 360 films introduced at the beginning of *Mother of the Forest* begins with Grant Grove, transitioning to Redwood Mountain Grove, and then to Lost Grove. I chose this trio for the introduction because they captured three important aspects: national parks, ecosystems, and sequoia trees. Grant Grove is the archetypal visual of national parks, particularly of sequoia groves. The forest is manicured—there are paved walkways, sturdy fences, informational plaques, trees with names, and tours throughout the trail. This is a managed park. But while it's beautiful, it feels more like a museum than nature. I transition into Redwood Mountain Grove to consider

what a more natural ecosystem of this species looks like. Here, bears dwell, the paths are less clear, and the forest is messy. It's alive. It's not manicured for humans the way Grant Grove is. It's an ecosystem. I chose Redwood Mountain Grove because I wanted the user to get lost in the forest. Finally, the last shot I include is Lost Grove. Here, the camera is embraced by two large sequoias. I wanted a shot where the user could get up close and personal with these trees, to feel their size and stamina. With the sunlight cusp at the tops of the trees, this was my favorite shot captured over the entire trip. It felt like the perfect space to transition the user into the speculative environment.

For the conclusion of the experience, I also created a collection of 360 footage from the parks. In this assemblage, I used Big Stump Trail, Redwood Mountain Grove, an overlook on Generals Highway, and Lost Grove. Big Stump Trail brings me sadness, because it is a clear patch that shows the history of human destruction to sequoias. This is a graveyard, a testament to "human progress". This scene shows what past human interventions in this forest looked like, in hopes that future relations can be more mutualistic. This scene then transitions into a spot in Redwood Mountain Grove where life, death, and renewal are displayed, as the user stands near a sapling, healthy trees, the cavity of a damaged yet living tree, and the remains of trees destroyed by fire. This is the life cycle of many trees of the forest, condensed into one shot. From this scene, the user is transported to an overlook of the forest from Generals Highway. This scene provides a macro perspective, an ability to look out over the forest in order to contemplate what the future of this place might be. In conclusion, the user transitions to the final moment of *Mother*

of the Forest, as they are placed back in Lost Grove, but this time, surrounded by ancient sequoias, both fallen and standing.
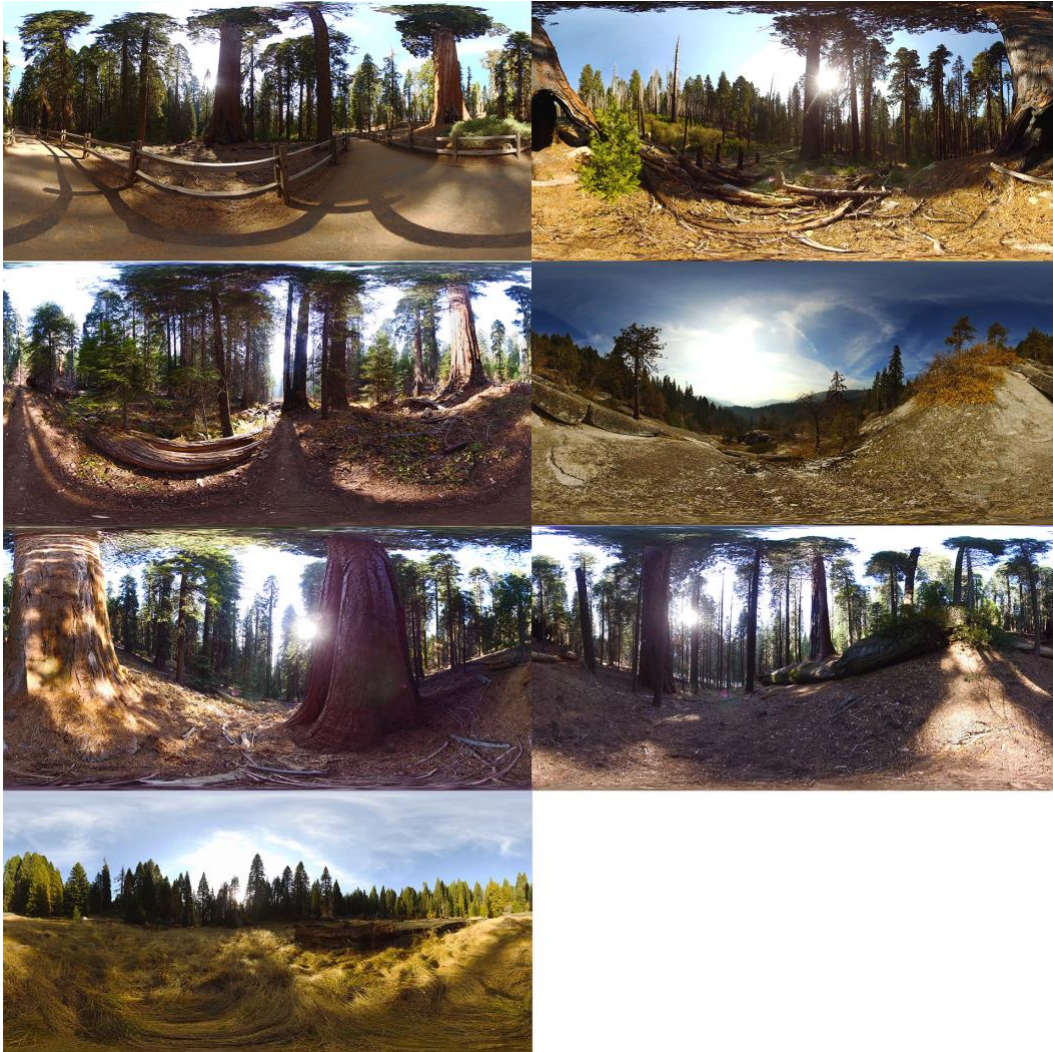

FIGURE 16. Final 360 footage selected for *Mother of the Forest*. From top corner, going clockwise: Grant Grove, Redwood Mountain Grove, Generals Highway, Lost Grove, Big Stump Trail, Lost Grove, and Redwood Mountain Grove.

During this production, I gained insight into the 360 film process, as well as my own creative process. One of the limitations of 360 footage is that the camera records everything. Traditional lighting and film camera techniques don't work particularly well for 360 film, because you can see the equipment driving the production. Therefore, I had to rely on the natural lighting and location of the forest. Similarly, 360 footage also requires the filmmakers to be in the shot, or hidden out of sight. While this may be difficult in large empty spaces, luckily for me the sequoia forest provided a perfect context for 360 film. I had the largest trees in the world to hide behind (and within) during recordings.

While lighting, location, and efficiency were obstacles I learned to work with during recording, I also experienced some hurdles in post-production. Although Insta360 Pro comes with its own software that works very well, I noticed that in several of my stitched recordings the 360 footage broke at the seams near the top and bottom, creating swirls of branches and dirt. While this is frustrating as an artist, part of me appreciates that a sequoia's height can break this technology. The sequoia will only allow a hint of its beauty and magnitude in 360, requiring people to come experience them in person.

During post-production, I spent a lot of time tinkering with color correction. I dwelled on getting the perfect exposure, lighting, and contrast. I continuously attempted to boost the greens to feel more like a forest. Yet, I never found a color correction I was happy with. Later, I recognized that I was misrepresenting the forest. A forest is not a movie set – and this project is not about a perfect setting.

The forest is untidy, with dirt, branches, trees, species, wind, and clouds. The lighting is not perfect; the forest is not orderly; there is liveliness and deadness. This is also not spring or a time of renewal: it's November. Therefore, there has been minimal color correction to this footage- only changes in exposure and contrast. I wanted to depict the forest as naturally as possible, to share the authenticity of this place.

On the other hand, I did decide to remove the tripod in post-production. At first, my inclination was to keep it, because I wanted the scene to be as unedited as possible. However, I found the tripod and its shadow distracting, detracting from the surrounding environment. I wanted to give the illusion of standing in the forest. Looking back, it's funny to me that I wanted a total erasure of technology to create complete immersion in a forest, while I ask the user to strap on a virtual reality headset… but here we are. Nature and culture binaries never seem to work. They are always involved in one another.

Overall, I think the implementation of 360 footage is quite important, and I want to thank Ana Serrano from the Canadian Film Centre for suggesting it to me. I believe it allows *Mother of the Forest* to transcend being an interactive, digital representation of an ecosystem. Instead *Mother of the Forest* compels users to ponder the real-life implications of human activity on our present and future world. It allows users to see their kin archived rather than digitally represented, reducing the cognitive dissonance some may experience while using VR technology to interact with digital depictions of this forest.

3.2.4 Digital Environment Production

After finalizing the 360 film portion, I jumped straight into the digital worldbuilding, what I consider to be the heart of this project. Using Unity Game Engine and various other resources,[15] I began to construct visuals and interactions that would complement the voiceover narrative. I wanted to create what Donna Haraway defines as world games: "inventive sympoietic collaborations that bring together such things as computer game platforms and their designers, indigenous storytellers, visual artists, carvers and puppet makers, digital-savvy youngsters, and community activists" (Haraway, 86). This is the Cthulucene and becoming-with: making through objective knowledge and subjective perspectives with others.

This portion of *Mother of the Forest* allowed for more creative liberty and freedom; however, I still wanted this part of the experience to be rooted in science. My first step was producing the digital ecosystem (Figure 17). I chose to create only one ecosystem which would be duplicated through each scene.[16] This would help logistically with scope, yet it would simultaneously provide consistency to the world, further allowing me to emphasize how different perspectives might perceive reality in the same location.

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[15] See Appendix D: Software & Resources.

[16] The mushroom scene does not use the exact same digital world, because it requires an underground environment.

FIGURE 17. Digital ecosystem.

While the scenes may look different, they are only different based on: 1) the location, scale, and perspective of the user; 2) the sky and lighting; 3) the rate of the passage of time. I like how each perspective seems both familiar and foreign (Figure 18). It fits nicely into Anna Tsing's concept of landscapes as active, lively things, "products of *unintentional design*, that is, the overlapping world-making activities of many agents, human and not human" (Tsing, 152). The perspectives of the same landscape prove that, even in the same location, there are many stories to tell, many histories hidden in all sorts of places. As Tsing notes: "this *is* the story" (Tsing, 158). I believe this is what it means to practice "worlding".
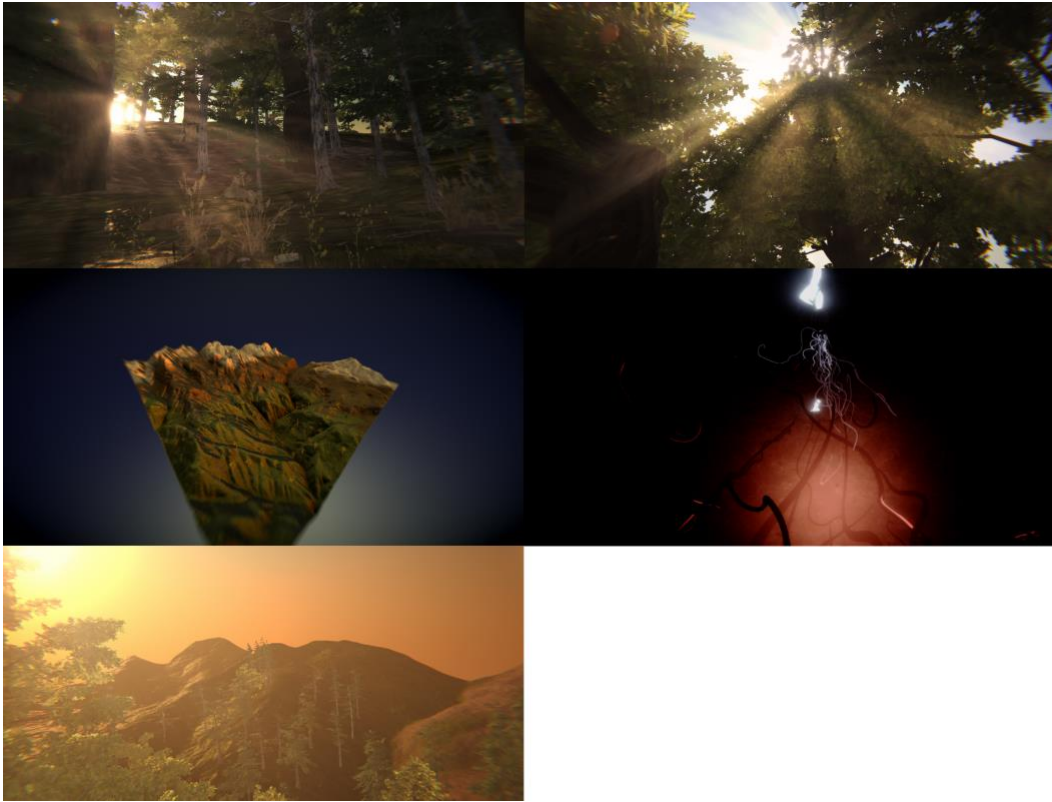
FIGURE 18. Various perspectives in the ecosystem. From left corner, clockwise: human digital perspective, squirrel perspective, mushroom perspective, tree perspective, ecology perspective.

While I was more interested in creating a representation of this environment rather than a simulation, I still wanted to find ways to implement some scientific information with my creative style. My first step was to create the terrain. Rather than loosely model what I envisioned the topography of this section of the Sierra Nevadas to look like, I downloaded a physical, political, and height map of the section of the forest I visited (Figure 19). The data from the height map could then be directly used to create a 3D model of the terrain, while the other maps could be used as references to pinpoint distinct locations I visited.
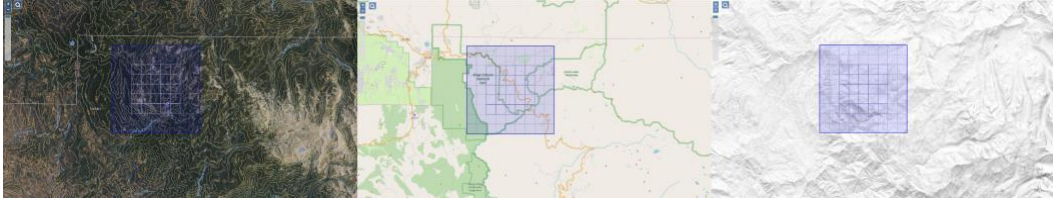
FIGURE 19. Physical, political, and shaded relief map of Kings Canyon and Sequoia National Parks. Downloaded from Terrain.Party.

I also created a gradient shader that was projected onto the model based on height, in order to divide up the different textures (Figure 20). The colors could then be mapped to different materials. While not a perfect simulation, in some sense, this is my creative interpretation of altitude levels and zones in the sequoia forest.
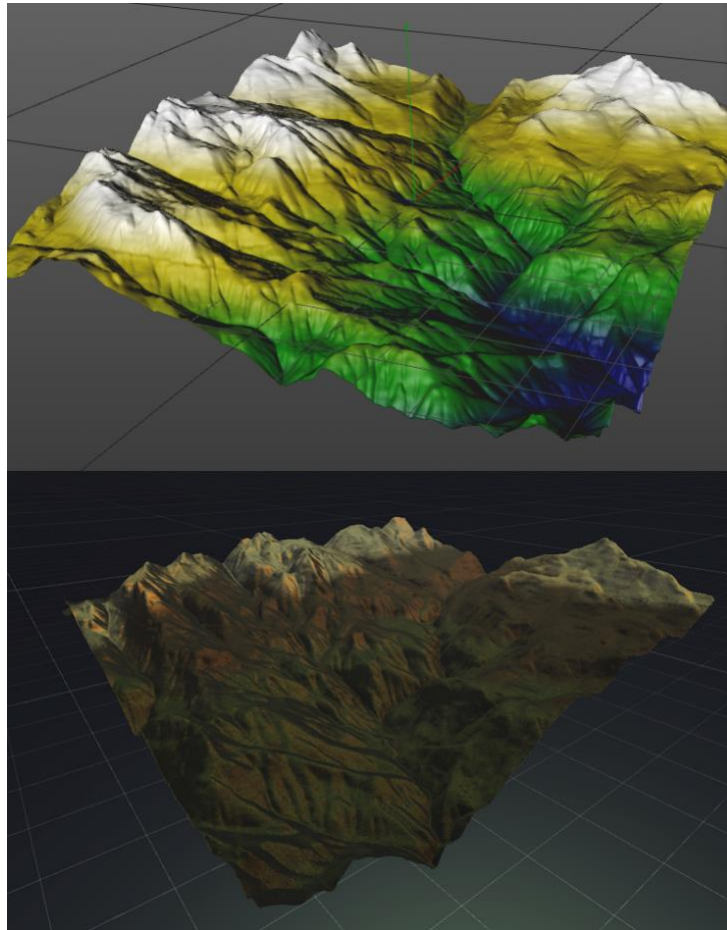
FIGURE 20. Terrain creation. 3D model generated from Kings Canyon and
Sequoia National Parks height map. From top to bottom: 1) Model created in
Cinema 4D with height map and gradient shader; 2) Model imported into Unity,
with landscape materials replacing the gradient shader.

To more fully represent this ecosystem, while staying within the scope of the
project, I decided to use photogrammetry models of the vegetation and species
native to the area, rather than attempt to model them myself. I did not create the
photogrammetry models myself (although in future work, I would love to add this
technique to my creative process). The photogrammetry models allowed me to

incorporate a sense of realism because the models themselves were based on scientific references. [17] Using National Park Service records to document what species were native to this region, I downloaded plants in the general vicinity to the parks. Yet, while I utilized assets that could be located around this region, I also took creative liberty and included some assets whose origins were unknown by me, yet nonetheless helped me fill out the ecosystem for aesthetic purposes.

After producing the ecosystem that would be used throughout the project, I began to focus on each species individually. What information was I attempting to visualize? What is their story? This particular part of the creative process became the most obvious implementation of *becoming-with* for me. With Douglas squirrels, my script focused on their interactions with sequoia pinecones. Therefore, I had to find a way to visualize their physical interactions with the pinecones. In order to do this, I imagined myself as a Douglas squirrel in the top of sequoia trees, as they move down the tree to the forest floor. My next visualization became more abstract, as I briefly switched from the perspective of a Douglas squirrel to a focus on a sequoia pinecone. While the pinecone is not a perspective to take on, but an object to look upon, I felt that it was important to momentarily step back from species embodiment to highlight how many seeds a sequoia tree produces in hopes of having at least one offspring. To tie into the previous atmospheres of particles, entanglements, and connections, I transformed a photogrammetry sequoia cone into a group of particles that outline the shape of

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[17] Many photogrammetry and realistic 3D models (such as SpeedTree) use the scientific and common names of plant species to differentiate the models.

the cone. These particles represent each sequoia seed in a sequoia cone (200 seeds per each cone). As the narrative moves forward, the user learns that sequoias produce somewhere around 11,000 cones in one year. In order to visualize this colossal number of offspring opportunities, the particle group expands to become a starfield of seeds, hinting at the patterns in nature that can repeat from micro to macro scales.

As I moved to the next species, mycorrhizal fungi, my designs became a bit more abstract. With limited knowledge in complex programming, I wanted to find a creative way to form simple interactions that would transfer to visual entwinements between the roots and fungi. I decided that, for this species, I would visualize a transfer of information through the "wood wide web" between fungi and tree roots, while also picturing their literal attachments to one another. This illustrates symbiosis: a sharing partnership between two entwined creatures that promotes liveliness.

Yet, as I moved to the sequoia tree, I felt a bit stuck. This was the central character of the story. They have so many stories to tell. Which story did I want to highlight? What would be the most effective visualization? I narrowed it down to two visualizations. I would visualize the passage of time by speeding up their life trajectory, from their initial attempts to find sunlight, to their longstanding endurance as ancient giants, and I would visualize their absorption of CO_2 through animated particle effects.

The theories of deep time, and species' perceptions of time were also important for me to visualize in this project. While species perceptions were straight forward (human time looks normal, squirrel time looks a bit slower to me, tree time probably looks like a time lapse to me), I realized there was something really contradictory in how I would represent deep time. I wasn't going to have the user sit for a long period to experience deep time. That was not feasible. Instead, I would rapidly accelerate time, to show the environmental changes that happen over vast timescales exceeding the human lifespan versus those that have happened within our lives. The idea that I would visualize slow changes over time in a time-lapse seemed oxymoronic, but I couldn't ask for someone to consider these concepts and stay in virtual reality for, well, forever. Then again, maybe the sudden flash of the Anthropocene could prove a point, as it becomes the "blink of any eye" of the monumental changes we're experiencing (Tsing et al., G1). Could this experience indicate the need for the Cthulucene, for us to learn to grow and work with one another for a more habitable future?

 Therefore, to represent these concepts of time, I focused on creating three different time rates (human, squirrel, and tree) with three different visuals: lighting, animation, and perspective. My first step was to focus on lighting. Lighting is an essential tool in film and photography for emphasis, tone, narrative meaning, and more. Lighting becomes an even more powerful instrument to signify changes in time. As my lighting came from the global illumination of the skybox and atmosphere, I used a cyclical sky, moving from day to night to emphasize the change in time. To pair this passage of time in the atmosphere

simultaneously with the rest of the experience, I animated elements of the environment to move with the flow of time. To further accentuate these movements and passage of time, I also generated a slight motion blur effect on the user's camera for the tree. While this passage of time between human and squirrel is not as obvious, the passage of time as a tree becomes noticeable in the user's perspective.

Once I created the general ecosystem, specific species visualizations, and different perceptions of time, my next step involved constructing the interactions and perspectives in virtual reality. This would create the sense of interactive play and perception that remains important for the success of this project, as a worldmaking, making-with research-creation. As Haraway notes, "perhaps it is precisely in the realm of play, outside the dictates of teleology, settled categories, and function, that serious worldliness and recuperation became possible. That is surely the premise of SF" (Haraway, 24).

3.2.5 VIRTUAL REALITY PRODUCTION

At the beginning of this exploration I was against using virtual reality. There were a few reasons for this: 1) the common conception that virtual reality is an "empathy machine" and hence becomes sort of a gimmick; 2) the fact that many people do not own virtual reality headsets makes it difficult to disseminate; 3) I often experience motion sickness from virtual reality. These factors worried me.

Yet, I was persuaded otherwise by my supervisors, colleagues, friends, family, and several articles I read on the medium. In her article, "Is Virtual Reality the Secret Sauce for Climate Action?", Katie O'Reilly discusses the use of virtual reality for climate change education and advocacy. O'Reilly lists several campaigns and films that use virtual reality to visualize the effects of climate change on the globe, from Yale University's *Reality of Global Climate Change* hackathon to Eric Strauss and Danfung Dennis's *This is Climate Change* series for virtual reality. In using virtual reality as a pedagogical, empathy, or advocacy tool for climate change, O'Reilly claims:

> It's one thing to logically *know* that humans are inflicting largely irreversible damage upon the natural world. It's another to see, hear, and in a sense *feel* what's happening from the perspective of those plants and animals at the front lines of drought, fire, and melting ice caps (O'Reilly).

Furthermore, the previous research mentioned surrounding immersive virtual environments impacting users' stance on cutting down trees, as well as the use of effortful interaction for polar bears and melting ice, caused me to reconsider virtual reality and interaction as effective tools for environmental communication. While my application of virtual reality does not explicitly attempt to guilt someone about their actions (as I imagine an immersive virtual environment about paper consumption and cutting down trees would make me feel), I did find it interesting that immersion and interaction can produce a greater change in behavior as it

urges the user to feel the subject physically and viscerally, versus watching or reading information on the same subject. I decided to give it a try, and I can (begrudgingly) say that I believe it has changed this project for the better.

As I began this creative process, I knew there were two elements I would need to create: perceptions and interactions. While creating a squirrel's perspective felt relatively straightforward, the other species in this project were a bit trickier. Plants and fungi don't have eyes (in the way we do) to visualize and process information. They depend on other sensory methods to process information. Although I tested other ways of visualizing (point maps, particles, blurred colors, lightness and darkness), I always returned to more familiar visuals. I didn't find the other methods particularly useful or compelling for the story. While I acknowledge that plants and fungi don't see the way that we see, I decided that for the ease of the user and for my objectives to get the story across, I would stick with human/animal eyesight as I perceive it. Instead, I rely on changes in exposure, time, scale, or other camera effects to portray the perception of other species. I think this is an obstacle I did not fully overcome. My ability to become-with these species was shrouded by my own anthropocentrism.

Another aspect of virtual reality production that can prove tricky is moving users around an environment. Virtual reality can produce motion sickness for many users, whether it stems from lagging graphics, latency in movements, or a cognitive discord as our bodies move in virtual space while stationary in physical space. This last point is commonly fixed through teleportation locomotion. Luckily, *Mother of*

the Forest involves a standing human, an entwined fungus, and a rooted tree. I only had two movement obstacles to overcome: the squirrel's movement throughout the tree, and a growing sequoia. For each of these, I created slow movements between locations, from branch to branch, ground to sky. Although it can be a bit jarring to move between locations, I felt like movement was an important aspect of becoming a squirrel and growing like a tree. While I tried to minimize the likelihood of motion sickness, I also find that a bit of discomfort can provide the sensation that you are no longer human, that this experience is about moving away from the individual to a collective understanding.

Because my target audience for *Mother of the Forest* is not virtual reality or digital game enthusiasts, but general audiences, I observed how different people (friends and family ranging from age 12 to age 82) without previous experience in virtual reality interacted in all sorts of virtual reality games. I noticed that VR experiences with only one or two interactions were the most successful. The more types of interactions, the more time dependent, and the more precision required by the interactions, the more complicated the experience became. These factors discouraged some users from playing. While some users with greater technological proficiency stated that the difficult interactions were "more fun", I remained committed to reaching general audiences with an experience that did not require prior knowledge or skills. Therefore, with these observations in mind, I created only one type of interaction in *Mother of the Forest*: pointing at targets. These targets do various things, but they are the same interaction. The targets are identical to the tree rings, therefore visualizing a correlation between different

species, their connection to these trees, and the stories the trees physically indicate. As the user moves throughout the experience, targets materialize when interactions are required.

I realize some users might say that this experience is not truly "interactive" because there are limited interactions, the experience has a linear movement, and their actions do not have implications on the environment or story. However, I believe that interactivity is on a sliding scale. While users do not change the outcomes, their presence and interactions within the immersive experience itself allow them to experience various perspectives, times, spaces, and scales. If the art of small interactions such as looking, pointing, and immersion helps users to experientially understand and contemplate our collective ecology, I maintain that, rather than producing a highly interactive, yet potentially distracting experience, this level of interactivity makes a more introspective experience possible.

During evaluations with others, I received feedback that users felt a lack of embodiment because they could not see arms attached to the controllers, and in many scenes, they do not possess a body/form. While I understand that looking down and seeing no body, or not having arms that match movements may feel at odds with virtual reality embodiment, this ultimately was not negotiable for me. If I were to include these assets, the interaction would either be uncomfortable (for example: tree branches move slowly, which would require the user to move slowly), the interaction would need latency introduced to keep a sense of realism, which can be nausea inducing, or it would potentially become silly and distracting. I did

not want to create a squirrel holding controllers or pointing a furry finger. A fungus does not have arms, and I did not want to produce hyphae tentacle things holding controllers. This is not The Wizard of Oz: I don't want branches to become arms that flail around. While this may be an area to contest, I felt that such an approach risked descending into trivial anthropomorphism. As stated throughout this process, I wanted to strike a balance between scientific validity and artistic creation. And while this might in a sense be a way of *becoming-with,* and it may produce something fun, entertaining, or compelling in other experiences, this was not the kind of experience I was creating.

For me, experiencing a species perspective in any format is fascinating in itself. But even the slight change in experience, from a computer screen to something strapped onto your head, can create a very different feeling of immersion. I think virtual reality is best experienced when you are alone. For many media producers and consumers, virtual reality is about performance, as it becomes as much about producing entertainment for a spectating audience as it is about being in the experience. Yet, I find it more significant as a tool when used in solitude, by myself. If you let it, virtual reality has the ability to move you to a faraway place, away from your sense of self. If the content is compelling, it can provide a moment of introspection sometimes lacking in other media.

3.2.6 TUNING IN: SOUNDSCAPES OF SEQUOIAS

In order to compliment the visual and interactive elements of this multispecies storytelling experience, it was important for me to devote time to exploring the audio production of this creative process. I wanted to recreate the vibrations, rhythms and oscillating sounds that I encountered in the forest. I wanted to strike a balance between recorded sounds of a forest, created sounds in a studio, and human articulations of these unfamiliar stories in the sequoia ecosystem.

While environmental degradation is usually presented in visual terms, from piles of electronic waste, to plastics in the ocean, deforestation, and chemical spills, sound is an equally vital aspect of healthy ecosystems that is often overlooked. In Brian Kahn's article, "The Quietest Place in America is Becoming a Warzone", Kahn recounts visiting the quietest place in America: Washington's Olympic peninsula. According to Kahn, this location's designation is being slowly stripped away as planes and other human developments encroach on this quiet space, producing noise pollution that has serious implications for nature, including humans.

Within the sequoia forest, I noticed this combination: moments of human noise pollution, moments of natural sounds, and moments of silence. During the simultaneous tasks of interviewing and recording through my hike within these forests, I practiced a new layer of *becoming-with* these species and ecosystems. I intently observed and noticed the ephemeral and ever-present sounds surrounding me. It was a somewhat strange experience for me. My first realization was that I

don't typically notice sound in my day to day experiences– I suppose I float through life without detecting the sounds that drift by. In this moment, when I consciously began to notice the sounds around me, it was an extremely visceral experience, akin to a form of information overload. Looking back, this feeling has become particularly strong for me in large cities (such as Toronto). Yet, in the sequoia forest, there were undulating waves between melody, cacophony, and silence. A Douglas squirrel barks at a neighbor, followed by sounds of footsteps scurrying away; a woodpecker diligently digs out a spot to place an acorn; a swift rush of wind whistles through the trees; a car drives by, windows rolled down, music ringing; road construction blares through the canyon; fighter jets fly across the sky; and then, silence. While I am unsure if I was perceiving genuine silence, or if my brain was fatigued from exercising this new practice, it felt like every time I grabbed the audio recorder, silence would swallow the area. Silence seemed to envelope the sequoias deep within the canyon, away from roads, construction and civilization. The trees are so tall, it's difficult to hear the wind in their treetops. Yet, even in that silence, there were brief moments of noise: species movement, snapping twigs, falling branches, human voices, car locks, or traffic horns in the distance.

In order to produce audio for *Mother of the* Forest, two overarching themes were used as the basis for audio creation: mimicry and polyphony. Mimicry is an evolutionary phenomenon where one species resembles or impersonates another species or object. Mimicry can be applied to many senses, but here I focus on acoustics. While mimicry is generally used as a survival tactic in biology, I apply mimicry more loosely, similar to how biomimicry uses models of nature to solve

human problems. Mimicry becomes a practice that I too am involved in, as I worked with my main audio producer, Brett, to recreate the sounds and atmosphere I recognized in the sequoia forest. This entailed an assemblage between four audio sources: forest recordings, the creation of Foley sound effects, voiceover, and score.

The audio recordings I attempted to capture in the forest ultimately did not turn out. Perhaps it was the equipment I used, or the quality of sounds, or perhaps I was too wrapped up in being in the forest. Whatever it was, they ultimately didn't come through in the recordings. Meanwhile, Krista put me in contact with a National Park Service scientist, Erik Meyer, an ecologist from Sequoia and Kings Canyon National Parks. Erik and Dr. Jacob Job of the Colorado State University Listening Lab record sounds of ecosystems to measure changes in biodiversity. Through acoustic recordings, they archive soundscapes of the forest.

Unfortunately, during the height of my thesis creation, the longest government shutdown in U.S. history began. This resulted in government employees, including ecologists like Erik, being furloughed for 35 days. It also resulted in the shutdown of Sequoia and Kings Canyon National Parks. In a rippling effect, this created an obstacle for me, as I was unable to reach Erik Meyer for soundscapes, I was unable to access some scientific research on the National Park Service website, and I was unable to retrieve the voiceover recordings from Krista. Therefore, through an act of mimicry, I first relied on other forest recordings as well as the creation of sounds to resemble and impersonate sounds I experienced in the forest, from the illusion

of trees creaking, to creative audio patches alluding to looming empty spaces and the passage of time. Luckily, the government shutdown came to an end. I was able to access forest recordings from Erik, who provided me recordings from Dr. Jacob Job, as well as voiceover from Krista. This was an important step to this process: working in collaboration with those who devote their lives to these forests.

Through this collection of recorded sounds, created sounds, voiceover, and musical scores, I practiced the craft of polyphony. Polyphony is "music in which autonomous melodies intertwine"; it is the assemblage of various melodies, creating conflict and harmony, where melodies can be singled out individually, or heard collectively (Tsing, 23). This was yet another experiment of worlding: finding the rhythm of an enduring ecology in precarity, as vibrant materials, species, and systems work together and against one another. In order to use the various pieces of audio, I had to find a way to weave them into one another, as one fades into the next, complements the other, drones out the former, and anticipates the latter.

Overall, by tuning in with this ecosystem, I attempted to listen to my complete surroundings, in order to understand the sense of immersion sound can create when one becomes truly present in a space. Through the observation of sounds in the forest, the speculation of sounds and feelings experienced by these species, voiceover narration, and the digital production of accompanying sound effects and melodies, I used speculative fabulation to create a polyphony of sounds that would complement and form the experience. My intent was to create a resonance – a

vibrating effect that could be felt between digital bodies of *Mother of the Forest* and tangible bodies of our world.

3.3 WEAVING IT ALL TOGETHER

During the creative making in each of these sections, I carefully balanced the science, art, truth and beauty as it materialized. These seemingly separate pieces were then combined into one cohesive form, resulting in an interactive, immersive virtual environment. Through speculative fabulation, these storytelling and worldmaking practices interact, as they both intentionally and unintentionally harmonize to create a collection of interwoven stories, spaces, interactions and times to consider. Throughout this assemblage, it was imperative to not let one piece of the creative process overwhelm the others. Rather, a balance was met between all the constituent parts – to maintain holism, an essential ingredient for ecological thought, communication, and advocacy.

RESULTS & REFLECTIONS

4.1 FINAL OUTPUT

The final result of this research-creation is an interactive, immersive experience, where users experience a sequoia ecosystem through various embodied species' perspectives to highlight themes of collective kinship, entanglements, and holism. Using a virtual reality headset and controllers, users who step into *Mother of the Forest* are introduced to the hollow space of a sequoia ecosystem under stress. As users move into the tree trunk, they are introduced to the notion that trees are storytellers. Glowing rings slowly move forward, representing the rings of a tree trunk and the stories they hold of many entangled histories. These entanglements are visualized between tree, fungi, squirrel, and human.[18]

The user transitions to a didactic moment, where footage of various locations in the sequoia forest is complemented with voiceover by Krista Matias explaining the history and context of this forest. The user is then transported to the digital ecosystem where they will remain for the rest of the experience. Through didactic

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[18] See Appendix E: Thesis Exhibition Documentation

and experiential approaches, the user embodies a squirrel searching for a pinecone, fungi sharing nutrients with a seedling's roots, a sequoia reaching for sunlight, and an ecology changing over time. Throughout this experience, different perspectives, stories, spaces and times illustrate how individual beings jointly form collective communities that are together entangled, together precarious due to climate change. These themes nod to the notion of kinship, to have users consider the effects of environmental degradation on beings that aren't always at the forefront of our awareness, but who are impacted nonetheless and can affect our lives. The user ends the experience with another didactic moment, as they visit another collection of recorded footage of the sequoia forest. Yet, this time the footage depicts tales of ruin, death, regrowth, life and uncertainty. As the user leaves the experience, they are asked to consider: what is the future of this forest, and what can we do to keep it thriving?

4.2 PERSONAL REFLECTION

I began this journey by wanting to find ways to make sense of the environmental issues that echo across places familiar to me. I find it hard to come to terms with the idea that humanity may, in fact, end, like the countless other species that have and are becoming extinct. The grim possibility of global migrations, depleting resources, and planetary conflict induce a chilling effect in me. Yet, as I began this journey, I am reminded that evolution is not necessarily about survival of the fittest: it is also a partnership, a community that evolves together. It is symbiosis. Some may argue that this is yet another example of a romanticized outlook on nature,

but I don't believe so. I believe that it gives me some sense of agency, to feel that this journey is a struggle together. It involves work, it involves care, and it involves evolving. I think a term like "Anthropocene" is scary because the end to its story seems so inescapable. And maybe it is. But it doesn't have to be. I think acknowledging that we have transformed the planet, and being prepared to get our hands dirty to repair it can also be a story of the Anthropocene. I think the stories of human beings as God's ultimate creation, the marvel of human revolutions of progress, and humans as separate from nature, are coming to a close. And I look forward to the end of those chapters. It makes room for new ones. I think there are a lot of stories and worlds to explore, and if we start now, maybe we won't lose as many creatures to environmental destruction—ourselves included.

A while back, I introduced myself to the science of environmental studies and the effects of climate change. It was a bit intimidating to figure out how I could help. I really wanted to contribute to the fight against climate change, for other species, and for better futures. In my naivete, I felt that topics like science, government policy, and engineering were the obvious answers, and maybe I should just leave it to the experts. Maybe I would do well to place my hope in them, trust that they will find the answers. But this felt so passive, almost a denial of what was happening around me. I realized that, with a background in filmmaking, my craft was making worlds to tell stories. And in whatever way I could, I should try to use my skillset to help the cause. Even if I fail, at least I will know that I tried, that I didn't sit idly by, hoping that someone else would step in.

When I began this project, I considered making this research-creation for children to introduce them to various environmental concepts. This led me to create simple mechanics in order to easily interact with the environment. Yet, as the project grew, I realized that the concepts articulated in the voiceover might be a bit advanced for some children. Yet, the simple mechanics were still helpful for those with little to no experience with virtual reality. This experience is made to inform and inspire environmental action, not to leave users confused by the technical components. Therefore, while my intended audience shifted from children to adults who possess more political power, I still want this experience to be available for a wide audience, young and old, ranging from those with no experience interacting with digital media to virtual reality enthusiasts.

I began this project with one question: *how might immersive experiences cultivate a deeper understanding of complex ecological systems among users, in order to promote a more holistic understanding of nature?* Yet, this was too big of a question to answer without a specific focus. I couldn't possibly illustrate ecological systems with one model to encapsulate them all. Therefore, I searched for a case study, and in that search, I found sequoias. My answer to representing an ecological system and holism became entangled in the plethora of species of this forest community. With this case study, I developed my thesis research question: *in what ways can immersive experiences represent a sequoia tree's ecosystem, in order to communicate to users various perceptions of time and space, symbiosis, climate change, and environmental changes over time?*

My first step in answering this question was to collect the information from experts in the field. While I did receive snippets of scientific facts about this ecosystem, we also discussed grander ideas that reach beyond specific species, resulting in a more holistic understanding. Krista noted that the future of these forests depends on how we manage and treat them. She stated that these trees, their fellow creatures, and the parks, are ecosystems that rely on management aimed at "ecological integrity", where ecosystems and their creatures are considered as part of a complex whole, not as objects in isolation, and where previous management approaches emphasizing tourism are now balanced with scientific research to preserve and protect these ecosystems for future generations (Matias).

Originally, I had a goal of communicating this information by being as objective as possible. This is scientific communication, after all, and introducing subjectivity to "objective truth" creates space for cynicism. As mentioned before, I didn't want to fall into the trappings of anthropomorphism or anthropocentrism. But I realized that, through art, I don't believe I can be absolutely objective. I can communicate information, but the way that I communicate this information is subjective in itself. And this is for me, one of the most important lessons I've learned through this process. My experience is a part of this world, too. Removing my subjectivity does not result in objectivity: it results in absence. As Jane Bennett notes, "Maybe it is worth running the risks associated with anthropomorphizing (superstition, the divinization of nature, romanticism) because it, oddly enough, works against anthropocentrism: a chord is struck between person and thing, and I am no longer above or outside a nonhuman 'environment'" (Bennett, 120).

This point was echoed during my interview with Dr. Brigham. Dr. Brigham noted that "there's all this research that shows that just shouting facts at people gets you nowhere… So understanding how to help people connect to places that they haven't ever visited, but that their actions are impacting, is, I think, a huge issue for humanity at the moment" (Brigham). According to Dr. Brigham, this could be done through art:

> Art is very compelling, it's better at overcoming issues around values and helping us imagine things that are unimaginable. I mean, one of the issues we are dealing with is that we, our brains are very deterministic, what happened in the past shapes what you can envision for the future. So, if we can't envision all the southern sierra burning up in a mega fire, then we won't do anything to prevent it. And, things like film and video and writing and painting help you overcome those mental limitations, and engage other people in the dialogue, in the conversation, who do not care about my graphs, and do not relate to… 2 degrees does not mean anything. Art and technology help make meaning (Brigham).

As our conversation turned to the use of immersive technologies, we arrived at another interesting point of discussion: can a virtual experience replace your physical presence in that forest? What effect would that have on society, or the division between nature and culture? Dr. Brigham's response:

I wonder, that's one of the things that makes me so curious about your project, is I would love it if people … did feel… that visceral connection and emotional connection to the place, but I just don't know… The idea that you wouldn't actually have to go there to experience it gives us [ecologists], well, some of us, dissonance, like cognitive dissonance, but I hope it works. Because, not everyone can come… And if the only people who care about it are the people who come visit, that's not going to be enough, by any means (Brigham).

This led me to consider: can virtual reality invoke action for a place not proximate to the user? Could the user still be inspired to act in a distant community's best interests? Perhaps virtual reality can create a connection to a place, a community, that doesn't require their physical presence. I am still exploring these questions, although I am leaning towards an affirmative answer.

Through the production of *Mother of the Forest*, I sought to answer these questions by pursuing what I believe to be a collaborative creation. *Mother of the Forest* is the culmination of objective, scientific research and my, subjective experience, but it is also multiple experiences. I could not have made this project without the work of theorists such as Donna Haraway and Anna Tsing. I could not have made this project without the construction of creative tools, the resources and tutorials of many that I leaned on to produce this. I could not have made this project without the help of scientific rigor, from secondary research, to the expertise of my interviewees, to the assistance of Krista and Erik in the production of this piece. I

could not have made this project without the species in this forest. This is my project and thoughts and research on paper, but it is also more than that. Like everything in life, this has been a collaborative process of entangled knowledge, skillsets, and experiences.

I learned that, while *becoming-with* is a rewarding process, it is also tedious and exhausting. Envisioning the perspectives of many species takes effort, both in an imaginative and critical fashion. When paired with something like climate change, it sometimes felt like a heavy weight placed on my shoulders. But maybe that's the point of *becoming-with*. I'm hesitant to use the word empathize, because these are my imaginings of their experience– they are not specifics that these creatures have communicated to me. However, through finding ways to visualize their perceptions of a habitat, time, and relations with other beings, together they can tell the story of a place. These stories are interwoven pieces that become a holistic picture of a community we are a part of, and we should struggle to support.

This is the answer to my research question, alongside my creative work, *Mother of the* Forest: through a becoming-with practice, multispecies storytelling emerges. Employing these theories and methods during immersive media production can create a deeper understanding of ecological systems for more holistic representations of nature. Through the assemblage of various media (such as 360 film, scientific fact and fiction, digital production, and audio), immersive media can use various *becoming-with* exercises to promote holistic representations of

ecologies, and in my case, multispecies storytelling specifically enabled me to represent a sequoia ecosystem and many of its intricacies.

CHAPTER 5

CONCLUSION & FUTURE WORK

5.1 CONCLUSION

This speculative fabulation emerged from an assemblage between my past history, my present being, and the insights I have gathered through this journey, along with the histories, beings, and insights of others, both human and beyond. While I have always felt an inkling of kinship with my fellow beings, *Mother of the Forest* provided me with the opportunity to dive deeper into the interweaving connections between myself and my surroundings, further illuminating the connections hidden from my view, as well as those that don't revolve around my human presence.

During this project, I began by introducing a poetic yet scientific fabulation of trees as storytellers. This allowed me to explore moving away from anthropocentric views of environmental destabilization, in order to incorporate a different way to communicate environmental information: multispecies storytelling. I sought out new forms of environmental communication, by considering how immersive environments and interactive media paired with didactic and experiential learning

methods could help illustrate complex ecological systems and holistic thinking as we plan for multispecies futures. I contemplated how I could produce a digital media creation capable of promoting agency and action for environmental advocacy, yet could still be used by those unfamiliar with the technical hardware. I continued by exploring formative contributions to the interdisciplinary fields I have included, as well as creative works that have similarities to *Mother of the Forest*. The theories that shine throughout this process include ecological concepts such as climate change, biodiversity decline, symbiosis, and the perception of time; assemblage theories such as entanglements, becoming-with, and kinship; creative practices that find balance between scientific fact and creative means; and the practice of storytelling through scientific fact, future studies, speculative design methods, and worlding. With these theories in mind, I described how I created *Mother of the Forest* through a speculative fabulation methodology. Through the hybridity between science and art, history and future, and individual and collective, the storying and worlding methods culminated to form the final immersive experience, *Mother of the Forest*. Through recounting this experience, I reflected on the process, the lessons I learned, and the contributions I have made, bringing this culmination forward with me as I continue my creative practice.

Through *Mother of the Forest*, I gained an appreciation of the importance of learning how to read, see, sense, and contemplate ecosystems and their creatures. It emphasized to me that making meaning out of these practices can help us produce different visions of what life is like, and what life should be. These

practices can be used to communicate scientific information, or to produce creative works, but they can also do both, simultaneously.

According to Dr. Brigham, this is an "all hands-on deck moment" for our world and its inhabitants (Brigham). Science and art do not need to be divided, standing at a distance from each other. They can provide to each other, evaluate each other, and make their respective contributions stronger. As people continue to critique the nature-culture binary because it damages the way we perceive the world as divvied areas to be observed, analyzed, and studied, rather than as entwined in one another, it's important to acknowledge that this dualism still appears when science and art are placed together. In regards to *Mother of the Forest*, I have received comments from both fields: a scientist told me, "well, it's not science". An artist told me, "well, it's not exactly art; and it's not our job to communicate science". But I've also received encouragement from both fields, where I gained new recommendations on how to postulate effective assemblages between environmental science and art. So, I suppose to some, *Mother of the Forest* is a monster: a liminal being, like those mythological characters, transcending the limits of both art and science fields to meet their common link– to understand and describe the world that surrounds us. That's what *Mother of the Forest* is for me: a way for me to understand, describe, envision and share a nugget of the world that is part of all of us.

5.2 Future Work

One essential element I plan on incorporating is user testing. In order to assess the efficacy of this creative project as a communication tool, I will employ user testing to evaluate the affordances and limitations of *Mother of the Forest* as an interactive, immersive virtual environment for environmental communication and advocacy.[19] My focus group for user testing can be split up into various groups: those familiar with virtual reality and interactive media, and those with little to no experience with these technologies; those from creative backgrounds, those from scientific backgrounds, and those from neither fields; those who believe in human-induced climate change, and those who are skeptical of the validity of human-induced climate change. The rationale for these target groups is to assess what portions of *Mother of the Forest*, if any at all, work in educating and/or inspiring people about environmental communication, and what areas can be improved, in hopes to promote greater environmental advocacy.

User testing will be essential for my development as an artist and technologist, as I plan to further develop *Mother of the Forest* by gaining feedback from the Sequoia and Kings Canyon National Park community as a collaborative process of discussing areas to omit, include, and improve, with a goal of sharing this through film festivals, educational centers, and art exhibits. Furthermore, user testing will help me plan the methods I will use in my future interactive projects centered

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[19] See appendix C for user testing questionnaire.

around species and environmental issues, as I strive to work in this transdisciplinary field into my future.

Beyond discussing my own goals for future creative practice endeavors, I believe it's important to highlight that this area needs more research, projects, and "art-science activisms". Haraway emphasizes that "the high stakes of training the mind and imagination to go visiting, to venture off the beaten path to meet unexpected, non-natal kin, and to strike up conversations, to pose and respond to interesting questions, to propose together something unanticipated…" is crucial (Haraway, 130). She defines this as "response-ability" (Haraway, 130). We have a responsibility, or "response-ability" to contemplate, create, and share these encounters, stories and worlds, if we are to live and become with our kin. These constructions don't need to be immersive, or interactive, per se. But they do need to be creative and scientific, a coupling of "truth" and "beauty" in their own merits. In doing so, we have a greater chance of advocating for more equitable futures for all living species across the board.

Sequoias have provided me this avenue, indicating to me what other species can add to the overall conversation of the future. While ecosocialist Foster notes that "conflict arises between a social system geared to endless accumulation and growth and everlasting, nature-imposed, conditions of ecological sustainability and substantive equality", it's important to remember that growth and progress are not always negative, despite the resounding environmental effects of those terms when used under capitalism (Foster). The seeds we plant today may become the

magnificent trees of the future, growing alongside their (very) old kin, as they work together in producing new stories to tell those in centuries beyond our lifetime (Figure 21). This can be interpreted both literally and philosophically: the seed signifying new trees and new species – or the seed of a thought planted in the way we view, represent, and treat nature.

FIGURE 21. Sequoias grasp hold of one another.

If I had one sentence to describe what I've learned, it's as simple as this: making worlds is noteworthy, but only if you have someone to make, share, and enjoy them with. I conclude with something Dr. Brigham told me during my visit to Sequoia and Kings Canyon National Parks as we discussed the global ecosystem:

> This is our community, these are the organisms that came up with us through evolutionary time, they are your natural heritage, that belong to

you, and to lose that is sad, right? [To] not have the places be the things

that evolved together, have a continued journey together, is depressing.

And makes the world a less rich experience for human beings in general. I

mean, do you want it to just be us and the cockroaches? I don't, and I like

my commensals, [I] don't have a problem with pigeons, I love crows, I

like mice, racoons, I don't hate myself, [I'm] fine, but I want it to be a

rich experience, where as many organisms that evolve together

get to continue that amazing journey (Brigham).

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Appendix A

SCRIPT

SCENE 1: TITLE PAGE

SCENE 2: INTRO, TREES AS STORYTELLERS

How does our perspective influence how we interpret the world?

I wonder what stories a tree could tell us from its lifetime.

Do trees have memories?

Their histories are written into the core of their being.

Intricate, concentric circles form a dizzying display of life experiences that ripple

to the surface.

What is time for this ancient being?

Days bleed into weeks, bleed into years, bleed into centuries.

Time can last forever, or sail by without so much as a glimmer.

And yet…

gradual developments over our lifetime probably feel like swift changes over a

tree's lifetime.

Trees must stand their ground.

They are tethered to the Earth, and must face whatever life throws in their direction.

But they are not alone.

Our stories and lives are not in isolation.

We are entangled in one another.

Ecosystems upon ecosystems, like a fragile nesting doll.

We are nature.

Simultaneously looking out... and within.

SCENE 3: 360 FOREST

This is Sequoia and Kings Canyon National Parks, located in California. This is home to giant sequoia trees. These groves are sequestered to the Sierra Nevada mountains. Sequoias are one of the oldest living organisms on Earth, capable of living beyond 3,000 years.

Sequoias grow here simply because their needs are met; they have plenty of warm sunlight, they prefer well drained granitic soils, they get enough moisture, and they are exposed to fire, which is essential for the dispersal of their seeds. While not the tallest, in terms of total volume, they are distinguished as the largest trees to ever exist on Earth.

Sequoias also feature prominently in the worldwide conservation movement. Sequoia National Park was the second national park created in the United States National Park Service, and the first national park created to protect a specific species. A giant sequoia can be found on the United States National Park Service logo today.

Sequoias are not just species, but also ecosystems. Sequoias bring food, shelter, and life to many in these groves. They must be understood not as objects in isolation, but as a part of a complex whole.

SCENE 4: ARTIFICAL FOREST

The relationships between many kingdoms: plants, animals, protista, fungi, and bacteria, and their environment around them, are what come together to create a sequoia forest ecosystem. Through symbiosis, they both work against, and in tandem, with one another. Yet, when one species is impacted, the effects can billow through the system.

Use your controller to point at targets.

I wonder what life is like for a Douglas Squirrel. How do they experience the company of a sequoia tree?

SCENE 5: SQUIRREL & PINECONE

Find a sequoia cone on the floor of the forest. Use your controller to point at targets to move about the tree.

Douglas Squirrels live in coniferous forests near the Pacific coast, nesting in treetops and crevices. This territorial critter's chatter echoes throughout the forest.

Douglas Squirrels munch on a collection of treats—including sequoia cones.

Although they eat some of these seeds, they are more interested in the fleshy scales of giant sequoia cones. Thus the sequoia benefits from this interaction, as most of the seeds fall to the ground, giving them a chance to disperse.

SCENE 6: SEED → SAPLING

One sequoia cone holds around 200 sequoia seeds.

With 11,000 cones produced in one year, a sequoia tree produces a galactic quantity of seeds, around 300,000 to 400,000 in a single year. Over a lifetime of centuries, just one of these tiny seeds must flourish to extend the sequoia legacy.

If a seed manages to sprout, it may produce a seedling. With a long journey ahead, this little seedling needs help if it is to one day become a grand sequoia tree.

What entanglements lurk beneath a sequoia tree? What is life like for mycorrhizal fungi?

SCENE 7: MUSHROOM

Many of the relations that keep a forest ecosystem flowing are hidden beneath the surface.

Use your controller to send nutrients to the seedling.

A seedling's survival depends on the growth of their roots. One companion that assists the seedling is mycorrhizal fungi. In this collaboration, the fungi penetrate the plant roots outer cell walls and form tiny branched structures that help transfer soil minerals, nutrients, and water to the tree. In return, the fungi get a little of the tree's sugars, so both benefit from this tangled bond.

Through the help of a seemingly invisible organism, a small seedling becomes a charismatic megafauna that gives habitat, happiness, and life to many in the forest.

SCENE 8: LARGE TREE, CARBON INTAKE, TIME, DROUGHT

As a sequoia tree grows, it competes with other trees for water and sunlight, racing to the top of the canopy to be greeted by a warm bath of sunshine.

In order to grow, the sequoia absorbs carbon dioxide and stores carbon in its wood, and in return produces the oxygen we breathe.

As time passes, a giant sequoia will reach its maximum height of over 300 feet in roughly eight hundred years.

Unfortunately, these magnificent beings are under threat. Their ecosystem has been impacted by climate change.

The death of trees in this ecosystem means they cannot share nutrients with their mycorrhizal fungi. They cannot feed the critters of the forest, like the Douglas Squirrel. They cannot produce the oxygen we breathe. It also means they become fuel for high severity fires, releasing the stored carbon back into the atmosphere.

SCENE 9: SPECULATIVE MAP OF THE FUTURE OF THESE FORESTS

In Sequoia and Kings Canyon National Parks, climate change is already happening. Yet, while some species can adapt and change their behavior, the California drought pushed trees to the point where they could not adapt.

As the baseline shifts, we can't always clearly remember what a changing ecosystem looked like before. Our perception is clouded by the passage through time. What you recognize the sequoia forests to be, is not what your ancestors knew them to be, nor what our future generations will know them to be.

How do we acknowledge environmental degradation that we cannot always perceive, when our health, our food, and our global economy depends on the wellbeing of these ecosystems?

What is the future of the forest?

SCENE 10: TRUNK DECAYING, FALLING OVER, GIVING BACK TO THE EARTH

Yet, even at the end of a sequoia's considerable life, its legacy continues in the forest for centuries. When a sequoia finally falls to the forest floor, it is slowly consumed by decomposers for eons more. It gives back nutrients borrowed from the landscape that first delivered it life.

SCENE 11: 360 FOREST, WHAT IS OUR ROLE?

This is Big Stump Basin in Sequoia National Park. Ruins of sequoias sit silent, a graveyard of those felled by extensive logging during the 19th century.

Today, national parks are our collective playgrounds; where we make memories with our families, escape from the stress of work, where we find adventure and inspiration. But all of this is under threat.

It takes many wins and only one loss to lose a natural treasure forever and we live in a world of quickly changing values.

John Muir famously said "When we try to pick out anything by itself, we find it hitched to everything else in the Universe." If we look closely, it seems the whole world is a series of connections and we are still learning about how it all fits together.

What is our role in the future of the forest?

We can reduce our greenhouse gases. We can vote, donate, and volunteer. We can also engage with the other creatures and assemblages we live and participate with. This is our community, our kin. These are the organisms we grow with through evolutionary time. Unfortunately, not all are coming forward with us. But we can impact who makes it and who vanishes. Through symbiosis, life is possible. Through species relations, we must learn to continue on this rich journey with our fellow creatures and friendly giants, the Sequoiadendron giganteum. If we remember what is truly important, then these trees may well live for thousands of years to come.

INTERVIEW DETAILS

SEQUOIA ECOSYSTEM INFORMATION

Dr. Brigham and I discussed sequoia ecosystems and their relation to humans. Dr. Brigham began by pointing out something that I had never realized about sequoias. They are a strange lure to humans, as they go against humanity's common notion of plants:

> People love that tree, it's so impressive, and, we call them charismatic megafauna, because plants, people don't connect with plants generally, and ... people have studied how plant blindness... that you don't even perceive trees and plants, and that they're just part of the background noise, but sequoias are so big and so old, that they overcome that innate bias against them (Brigham).

Dr. Brigham stated her appreciation for the term sequoia ecosystem, versus focusing exclusively on sequoia trees. She revealed that, while sequoias are impacted by climate change, they are much less affected than any of the other trees within their ecosystem. According to Dr. Brigham, sequoia trees are not special in their relationships with other species; other trees have these relationships as well.

Douglas squirrels will still eat other things, mycorrhizal fungi are present in many plants, bats will roost in other locations. The only difference between this mixed conifer ecosystem and others is that giant sequoias grow there, which brings human attention to them.

CLIMATE CHANGE

Krista explained that these ecosystems are impacted by climate change, resulting in "increased drought severity", "bark beetle" infestations, "air pollution", "changes in precipitation", and more (Matias).

Dr. Brigham noted that the National Park Service has observed that with a two degree increase over the last 100 years, some species are adapting to the changes: birds are nesting earlier, mammals are moving up in elevation. But for trees, they are unable to adapt and migrate as quickly as animals. As Dr. Brigham explained, "there's been a long evolutionary arms race between all plants and the things that want to eat them" (Brigham). The fact that these plants are stuck and can neither migrate nor flee has left many trees to die. This is an important detail to consider: as Dr. Brigham expounded, "other than the ocean, they're the only autotrophs, so they're the only ones that make their own food. Without them, you're totally screwed" (Brigham).

Dr. Brigham stated that, due to anthropogenic climate change, mortality rates of some trees in the mixed coniferous went from "2-4%" to "10 to 30%", therefore exhibiting significant changes to the forest (Brigham). Others, like the five needle

sugar pine, experienced mortality rates of "70 to 90 %" over the 5 year drought in California. Yet, there was an even more significant point to this story. This localized example of climate change was visible to those living nearby, yet some continued to refute anthropogenic climate change. Dr. Brigham exclaimed, "there's 120 million dead trees. You can see the red trees. That's why I can't believe, it's astounding to me that so many people that live here don't believe in anthropogenic climate change, when, if you look in the mountains, you can visually see the impact of climate change" (Brigham).

Yet, giant sequoias had so far endured the effects of climate change. According to Dr. Brigham, they experienced no mortality rate changes initially, because they adjusted their water intake to prevent significant drought stress. Dr. Brigham went on to explain why these trees need water (to move nutrients from the soil up into the canopy, to photosynthesize, and to cool); how trees balance their water intake (through closing stomata or dropping leaves); and how, as a result of closing stomata and losing leaves, the CO_2 absorbed by these trees decreases, limiting their ability to make more wood and become greater carbon sinks. Eventually, a handful of giant sequoias died from drought stress and possible beetle attacks, but the mortality rates of sequoias were still far less than any of the other trees of the ecosystem. While there are lingering concerns about how many of these droughts these trees can tolerate, a bigger concern to Dr. Brigham is that sequoias will continue to be vulnerable to high severity fire due to the other dead trees adjacent to them. While sequoias need low severity fire to open cones, remove competitors,

and create nutrient rich soil, if fires become high severity and reach into the crown, it will kill these trees.

Furthermore, as sequoias' massive volume equates to gigantic carbon sinks that help combat climate change, when one of these trees die, they are not easily replaced. These trees can take centuries to grow. "There's a paper about how much carbon is stored in Sequoia National Forest and Yosemite National Forest, and it's crazy, it's megatons... So, sequoias store a ton of carbon, megatons of carbon, and they hold it for a really long time because they live so long, 3,000 years... It's not a short-term investment. It's a long-term storage... As long as we don't cut them down or burn them up in megafires, is staying there for the next, you know, 500 to 2000 years... So it is a large carbon sink, and when you burn it under different conditions, you're putting carbon back into the atmosphere" (Brigham).

USE OF ART AND TECHNOLOGY TO COMMUNICATE SCIENTIFIC INFORMATION

After describing the technical elements and themes I intended on exploring in *Mother of the Forest*, I asked Krista what her opinions were on the use of technology and art in communicating information about the national parks and their scientific research. Krista seemed to eagerly agree that they played a role in national parks. She mentioned various ways she could see technology and art being used within the parks, from communicating information in diverse languages, to helping visitors "engage with nature in a variety of ways", to helping people plan

their trips before they arrive, to allowing visitors to "[participate] in digital citizen science projects" or "[start] their own nature journal", to technology's ability to share experiences with friends and family abroad (Matias). Krista believed technology and art could help share the beauty and complexity of the national park experience.

WHAT IS THE FUTURE OF THIS FOREST?
WHAT CAN WE DO? WHY SHOULD WE CARE?

I closed our hike with the most important question for this project: what is the future of these forests? Krista replied:

> What is the future of these forests? Well, it takes many wins and only one loss to lose a natural treasure forever and we live in a world of quickly changing values. But I believe in the hearts of people. If the American people remember what is truly important, then these trees may well live for thousands more years to come (Matias).

I continued our conversation by asking: why should people care about these species and ecosystems? Krista responded with one of the most passionate statements I have heard for protecting National Parks:

> National Parks are our nation's collective playgrounds; where we make memories with our families, escape from the stress of work, and where we

find adventure and inspiration - just the idea of National Parks is worth saving. John Muir famously said "When we try to pick out anything by itself, we find it hitched to everything else in the Universe." Now if we look closely, it seems the whole world is a series of connections and we are still learning about how it all fits together. The definition of an ecosystem is *a biological community of interacting organisms and their physical environment*. This definition reminds us we must consider the importance of each piece (Matias).

In my interview with Dr. Brigham, she pointed out that she and other NPS forest managers have considered moving sequoias to a more habitable region further north, projecting what their future climate might be. Yet, this transport has to be done sooner rather than later. As Dr. Brigham states, "You have to... have so much foresight, because if we wait until we really know what the problem is, it'll be too late. Because [sequoia trees] take so long to grow" (Brigham).

We continued our discussion by considering humanity's agency in climate change action, national parks management, and ecosystem stabilization. Dr. Brigham explained that, in regards to climate change, the important factor that people oftentimes miss is that "the *magnitude* of climate change matters" (Brigham). While species have some adaptive capacities, the extent of temperature and moisture and geographical changes we place on species impacts whether they will survive or not. "What we do in the next 100 years to reduce that impact is going to make a huge difference in who makes it and who doesn't" (Brigham). With that in

mind, Dr. Brigham asserted that "*anything* people can do to reduce CO2 emissions" matters (Brigham). At this point I wondered, what will the next 100 years look like? I asked Dr. Brigham, what is the future for this ecosystem? She gave me two possible futures:

I think, and I could, I'm probably 100% wrong, because we all know our ability to predict the future is terrible... I think based on what I've seen it's going to go one of two ways. Either something catastrophic will happen. We will... continue to have megafires and the southern sierra will get hit repeatedly, and you'll have large landscapes where we have basically burned up almost everything, that will take 50 – 100 years to recover, and a lot of management to get back to a healthy forest, or, the change will happen so slowly that I'll get sad, and Nate Stephenson [ecologist] will get sad, but most people won't notice. And that's one of the good things about giant sequoias, we'll see them and care about them... So, I love them for that, that they're like "Wake up! I was here for 2500 years and you killed me! (Brigham).

USER TESTING QUESTIONNAIRE

Please check off your responses in the space provided.

I have experience engaging with interactive media.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I have used virtual reality before experiencing *Mother of the Forest*.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Before experiencing *Mother of the Forest*, I believed interactive media
could help communicate environmental information for climate change
and environmental advocacy efforts.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

During *Mother of the Forest*, I enjoyed changing perspectives between
different species.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Changing perspectives between different species allowed me to realize the
importance of multiple perspectives in an ecology.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I noticed the change in time scale when I embodied the sequoia tree's perspective.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

The change in time scale from the sequoia tree's perspective helped me visualize how their ecosystem changes drastically over time.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Mother of the Forest helped me visualize the connection between species in an ecosystem.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I believe storytelling from a species perspective can be used to visualize environmental information.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I prefer to experience various species perspectives in an ecology, rather than one species individual perspective.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I learned new information about ecologies after experiencing *Mother of the Forest*.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

I empathize more with species after experiencing *Mother of the Forest*.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Virtual reality helped enhance the experience of *Mother of the Forest*.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

After experiencing *Mother of the Forest*, I believe interactive media can help communicate environmental information for climate change and environmental advocacy efforts.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Mother of the Forest helped me realize my connection to wildlife and our ecosystems.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Mother of the Forest makes me want to advocate for environmental conservation and climate change advocacy efforts.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree

Do you have any additional comments or thoughts about this experience?

Appendix D

Software & Resources

2D & 3D Animation Production:

    Adobe After Effects

    Adobe Illustrator

    Adobe Photoshop

    Adobe Premiere

    Autodesk Maya

    Cinema 4D

Interactive Media Production:

    Material Shaders: Amplify Shader Editor

        (Unity Asset Store)

    Terrain PBS Shader: CTS-Complete Terrain Shader

        (Unity Asset Store)

    Sky and Lighting: Enviro- Sky and Weather

        (Unity Asset Store)

    Particle Effect: keijiro github

        (https://github.com/keijiro?tab=repositories)

    Scripting: Microsoft Visual Studio

    Environment Assets: Quixel Megascans

ENVIRONMENT ASSETS: SPEED TREE

PARTICLE EFFECTS: ULTIMATE VFX (UNITY ASSET STORE)

UNITY GAME ENGINE

VOLUMETRIC LIGHTING: AURA 2 (UNITY ASSET STORE)

VIRTUAL REALITY PRODUCTION:

OCULUS INTEGRATION (UNITY ASSET STORE)

OCULUS RIFT

360 FILM PRODUCTION:

ADOBE AFTER EFFECTS

ADOBE PREMIERE PRO

INSTA360 PRO

INSTA360 PRO STITCHER

360 SPATIALIZED AUDIO & SCORE PRODUCTION:

ABLETON

ADOBE AUDITION

H2N ZOOM RECORDER

OCULUS SPATIALIZER

OMNISPHERE 2

WOOD CREAK SOUND EFFECT: DHEMING AT FREESOUND

(HTTPS://FREESOUND.ORG/PEOPLE/DHEMING/SOUNDS/17

7779/)

AUDIO PRODUCTION BY BRETT CARAWAY & KYLIE CARAWAY

ENVIRONMENT SOUND EFFECTS BY DR. JACOB JOB OF THE

COLORADO STATE UNIVERSITY LISTENING LAB, ERIK

MEYER, SEQUOIA AND KINGS CANYON NATIONAL PARKS,

AND BRETT CARAWAY

VOICEOVER BY KRISTA MATIAS

THESIS EXHIBITION DOCUMENTATION

FIGURE 22. *Mother of the Forest* exhibition at TMAC, April 12-14, 2019.