I am the Lorax. I speak for the trees... As a child, I wore out my VHS tape of *The Lorax*. It tells the story of a curious young boy who meets a man who tells the recent history of his world. The Lorax's world was once beautiful, whose landscape was dotted with tall and colorful "Truffula Trees" that provided for the world's inhabitants. Due to human activity, the beauty was lost. The natural world, both the Lorax's and ours, is remarkable. After billions of years of evolution, we've arrived at this moment of incredible diversity of life, the beauty of which is now threatened. I seek to understand more about how diverse organisms have evolved and the profound impact humanity has on natural ecosystems. I will use my PhD to pursue a career studying humanity's impact on evolution, where I will amplify voices of marginalized populations to advance a global perspective.

Intellectual Merit: I give credit to Alka-Seltzer for launching my scientific career. What started as a home-cooked science experiment for fun in high school, using sodium bicarbonate tablets to increase CO_2 levels in plant-containing two-liter bottles, to mirror globally growing CO_2 levels, turned into an award in the Intel International Science Fair. My experimental design was questionable at best, but I learned that cleverness and curiosity are invaluable parts of the scientific process. So, as soon as I arrived on the Oregon State University campus, I sought a research experience guided by someone who could nurture my innate curiosity but also coach me in the finer points of the scientific process. After only three months on campus, I found the Morgun lab studying gene regulation of cervical cancer. In my project, I extracted and harmonized data from published studies about gene-gene interactions and used it to reverse-engineer regulation networks. This was my first experience in a genomics project, where I learned that "Big Data" is not easily digestible, but it sure is fun to play with! While volunteering in this lab, I found I was not interested in doing basic cancer research but had become enchanted by bioinformatics and all its potential applications. It inspired me to switch my major to BioResource Research with a Genomics option, allowing me to explore classes in diverse departments spanning from computer to plant science.

The next year, I wrote and was awarded a $1,000 research grant from the office of undergraduate research, leading me into the forests the Lorax and I both love, diving into the woods of genetic diversity in a new lab. The idea was to assemble chloroplast genomes for hundreds of trees in tropical forests of Panama whose genomes were only skimmed by sequencing – chloroplast copy number is abundant and thus high depth is not needed. I wanted to gain insight into features common across diverse taxa but unique in the tropics to understand how tropical trees can thrive in their climate. Further, what will happen to temperate trees when their climate becomes more tropical? Soon I encountered a problem that often plagues bioinformaticians: that of being the only person in the lab using computational tools. What I needed most was a mentor who could give advice on the tools germane to my research, like navigating the clunky NCBI website and BLAST.

With a growing curiosity about computational biology work, I saw the expiration of my grant funds as an opportunity to join a new lab with a bioinformatics mentor. I moved from studying genetic diversity at the massive scale of forests to studying genetic diversity at a microscopic scale – inside the microbiome of nematodes. I investigated potential endosymbionts of *Meloidogyne hapla* and how its microbiome changes over the species' life cycle from reproductive through infective stages. I was excited about the local impact of my work; potato producers in Oregon and Idaho typically lose between 20 and 80% of their crop after their field becomes infected, and characterizing the *M. hapla* microbiome could lead to new treatments in the form of either biocontrol agents or antibiotics. I presented my research, which turned into my Honors Thesis, to the public at a poster fair my degree program hosts every year. There, I translated the systems-level thinking my research demanded; as I told my audience, I studied the bacteria *inside* nematodes *inside* plants. This explanation resonated with the public, earning my poster the

People's Choice Award. I would later present my research to the public again at my thesis defense before publishing in the OSU Scholar's Archive. In my thesis, I studied a plant disease in parallel with a class I took from Dr. Kate Field, Emerging Infectious Diseases. There we discussed the rise and fall of dozens of human pathogens and their microbiology. It fascinated me that plants experience these problems as well, but these diseases are not well-known to the public.

For my graduate studies, I discovered a lab that combined my love for natural beauty and diversity with my interests in bioinformatics and diseases. My research in Dr. Niklaus Grünwald's lab examines the genomics of various *Phytophthora* spp. ("plant-destroyer" in Latin!), fungal-like pathogens of economic and environmental importance. For example, *P. infestans* is the infamous culprit of the Irish Potato Famine, caused when infected potatoes were transported to Europe from North America. My first manuscript, currently under peer review for publication, investigates population structure of a lesser-known *Phytophthora* in nurseries contributing to disease in natural forests. I've presented posters on this research at two conferences, discussing how human activity, such as sale of nursery stock, contributes to disease outbreaks. Interestingly, an outbreak does not occur every time a spore enters a new environment. For my PhD thesis, I will investigate how the genomes of certain *Phytophthora* species enable them to emerge, re-emerge, and dominate. My proposed research will compare the genome of *P. ramorum*, the pathogen responsible for Sudden Oak Death and destruction of my local forests (oaks and tanoaks, not Truffula Trees) in Oregon and California, to genomes found at its hypothesized Asian center of origin. There, the pathogen and host have long engaged in an evolutionary arms race of pathogen weapons and host defenses, resulting in both greater pathogenicity and greater host resistance. Through an advanced mathematical biology class beyond the scope of my previous academic work, I developed a strong theoretical understanding of evolutionary models (e.g., Moran process, Kingman's coalescent), launching my interest in molecular population genetics. Diversity in a newly discovered wild *P. ramorum* population is key to understanding adaptations allowing the pathogen's emergence.

Broader Impacts: As an early-career scientist, I adhere to a principle of open science. I place an emphasis on effectively communicating my research and enabling others to reproduce my results, regardless of their bioinformatics experience. I taught two workshops in the R programming language at the International Congress of Plant Pathology, using data my lab released alongside corresponding manuscripts. I was happy to help others who struggled as I did trying to learn bioinformatics on a self-guided journey. With my skills in R , I'm developing an R package (open source) to map sampling locations and associate that geographic data with genetic data from samples, all wrapped in a web application. This app can be used to demonstrate the role of human activity, such as nursery sales, in spreading disease through forests, but it has more uses as well. It will be published online on GitHub (@Neato-Nick), the industry-standard code repository, and licensed so anyone, from citizen to professional scientist, can develop the program further or adapt it for their own needs. This is similar to work I did with Dr. Charles Keller the summer before I started graduate school. I wanted to reinvest in cancer research with the bioinformatics experience gained in my undergraduate studies. I wrote and won a $6,000 grant from the Oregon Biosciences Internship Program to develop a program to allow members of the lab not trained in bioinformatics to select samples, upload new data, and perform analyses with the touch of a button. I sought to lower the computational barriers to cancer genomics and leverage the power of every lab member to gain insights into the progression of childhood cancer.

I first developed my ability to simplify complex tasks and ideas as an undergraduate student working in leadership positions inside and outside science. In my second and third years of school, I worked in the dorms on campus helping new students adjust to the college environment. One of

my objectives was to broadcast the thrill of research and mentor students who were looking to start research fresh out of high school, while they were still adjusting to the heavy workload of university classes. I faced this during my first year as a grad student when I enrolled in too many classes to maintain my research, resulting in a W on my transcript that will be resolved later this year. My dorm jobs were challenging and dynamic; the position descriptions included facilitation of complex social justice conversations. Later, I combined my love of the natural world with social justice as the Justice Coordinator for OSU's Student Sustainability Initiative. I planned events underscoring the intersection of social justice and environmental sustainability, like raising $2,000 from groups on campus to host a discussion of the leadership that Native communities have taken to slow climate change, facilitated by Winona LaDuke. My last summer as an undergrad, I led incoming student orientation groups. I was asked to highlight my research to demonstrate the success undergraduate researchers can have. In these positions, I distilled complex material down to its essence without oversimplification – the basics of science communication.

The Lorax said he "speaks for the trees for the trees have no tongues." While trees can't speak, young scientists from underrepresented groups have been speaking for years. However, their voices have been stifled by oppressive academic structures. I'm heavily engaged in community work because it elevates the voices of the most marginalized groups in society. To learn the best ways to accomplish this, I've joined national organizations. I started my involvement in the Society for the Advancement of Chicanos and Native Americans in STEM (SACNAS) several years ago and built a network with students of color pursuing research careers. As a part of the organization, I've volunteered at the PowWow OSU hosts on our campus each year, also using it as a recruitment tool for prospective students in Native communities. When I joined, I was an undergraduate and my mentors in the club were graduate students. Now, I am a graduate student and they are postdoctoral researchers. This past year, I have enthusiastically seized an opportunity to give back by being paired with my own undergraduate mentee. For two years now, I have mentored him in navigating a system that was not constructed with indigenous people in mind.

In a sister club, Minorities in Agriculture Natural Resources and Related Sciences (MANRRS), I further utilize my multicultural leadership skills. Holding multiple officer positions, I kept the club thriving by closely managing finances and designing a website to engage new members. Our club maintains a Jr. MANRRS chapter at Rosemary Anderson Alternative High School for students at high risk for not completing their degrees. At every national conference, I was assigned a Jr. MANRRS mentee who I introduced to my professional network and brought with me to activities. Throughout the year, we host the same students on campus and teach them about leadership, science, agriculture, and meet with potential employers like the US Forest Service. For one activity, after I took a class in plant tissue culture, I brought Jr. MANRRS into the lab and prepared cultures, teaching plant science and sterile technique. The students could see themselves as scientists, excitedly toting around their Parafilm-wrapped plates the rest of the day.

UNLESS someone like you cares a whole awful lot, nothing is going to get better. It's not.

Exploring my intellectual curiosity through diverse research projects, from cancer genomics to plant pathology, resulted in a deep understanding of how to conduct science and enabled me to connect several disparate realms of scientific knowledge with bioinformatics tools in a way that is accessible to all. As a life-long learner who has increasingly engaged in activities that reveal to me the educational and social disparities marginalized groups face, I care a *whole* awful lot. I *care* about this planet, its people, and how we interface with each other and the remarkable diversity of life. The NSF Graduate Fellowship Program will allow me to explore my unyielding curiosity while advancing my field of science and improving others' access to it on my path to professorship.