

Viewpoint

Tapestry Thinking: An Interview with Dr. Nalini Nadkarni on an Unexpected Life in Science

Alan C. Logan ^{1,*} and Nalini M. Nadkarni ² ¹ Nova Institute for Health, 1407 Fleet St., Baltimore, MD 21231, USA² School of Biological Sciences, University of Utah, 201 Presidents Circle, Salt Lake City, UT 84112, USA

* Correspondence: alanxlogan@gmail.com

Abstract: In the ongoing series of Nova Interviews, *Challenges* Advisory Board member Alan C. Logan meets with thought leaders, scientists, scholars, healthcare professionals, artisans and visionaries concerned about health at the scales of persons, places, and the planet. In this interview, Dr. Nalini M. Nadkarni, of the University of Utah, responds to a set of questions posed by Nova for *Challenges*. For over forty years, Dr. Nadkarni has been studying the fragility and resiliency of rainforest ecosystems. During this time, Dr. Nadkarni has prioritized science communication with an emphasis on highlighting the interdisciplinary relevancy of research findings. Dr. Nadkarni has worked to promote an integrative way of thinking about the various branches of science and medicine, with an eye toward shifting public policy. Her research career has taken her where only a small minority of scientists have traveled—from remote cloud forests to segregated housing within prison facilities. Dr. Nadkarni successfully challenged the Mattel Corporation to update their globally-recognized toy, Barbie, with women in science in mind. Here, Dr. Nadkarni reflects on the early influences that shaped her career, updates *Challenges* on the latest directions of her work, and discusses the ways in which the canopy ecosystem can help us understand the complex interconnected challenges of our time.



Citation: Logan, A.C.; Nadkarni, N.M. Tapestry Thinking: An Interview with Dr. Nalini Nadkarni on an Unexpected Life in Science. *Challenges* **2022**, *13*, 61. <https://doi.org/10.3390/challe13020061>

Academic Editor: Susan Prescott

Received: 15 October 2022

Accepted: 17 November 2022

Published: 19 November 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: microbiome; stress physiology; public health; personalized medicine; community health; planetary health; health inequities; non-communicable diseases; social determinants of health; serotonin

1. Introduction

Challenges is a unique interdisciplinary journal dedicated to integrating diverse scholarly discourse related to the grand challenges currently facing our societies and the planet at large. To that end, the journal is continuing its series of Nova interviews that cut across disciplines, professions, and perspectives. In collaboration with the Nova Institute for Health, these interviews seek out individuals with remarkable experience and wisdom; they are queried on their work, experiences, and the ways in which their ideas cut across disciplines in the promotion of health and flourishing at the scales of persons, places, and the planet [1].

Over the last decade, the scientific interest in the relationship between the natural world (captured by terms such as “green space”, “natural environments”, “urban nature”, “blue space”, etc.) and human wellbeing has grown dramatically. In particular, this research has emphasized benefits to mental health for those living in close proximity to green spaces, and especially for those who have access to safe natural environments rich in biodiversity [2–4]. Some research suggests that the potential value of natural environments to wellbeing is determined, at least to some extent, by an individual's connection to nature (also called nature-relatedness) [5]. Biodiversity appears to be an important factor in fostering a psychological connection to nature, which in turn is linked to pro-environmental behaviors [6]. Emerging research suggests that some of the adult losses of an early life devoid of time spent in nature include diminished creativity and diminished attention to

subtle sensory stimuli in adulthood [7]. Decreased opportunities to interact with nature reduces cognitive and affective relations to nature [8], and may compromise support for conservation and pressing environmental issues [9].

As this research has started to mature, it has become clear that access to green space does not sit on a level, equitable playing field—in westernized countries, green space availability and use is associated with socioeconomic advantage [10–12]. In the Global South, the available research also indicates that health benefits associated with green space availability run along socioeconomic lines, benefiting the affluent [13]. Thus, the potential to develop a meaningful relationship with nature, a personality feature that can be considered a health asset, is not evenly distributed through society [14].

Given the accumulating evidence underscoring the benefits of psychological connections to nature, both to the individual and the environment writ large, there is an urgent need to understand how such connections are made, and how we can ensure an equitable distribution of a health asset. Natural environments are well known to induce the positive emotion of awe in children, which in turn promotes ecological behavior. However, even this bridge is connected by nature relatedness—the relationship between awe and pro-environmental behavior is mediated by connectedness to nature [15]. How, then, can we ensure that all children have an opportunity to experience the awe of natural environments and build up a connection to nature? If nature-relatedness is a basic human psychological need, as proposed by two separate groups of experts in 2019 [16,17], then are we doing enough to satisfy that need, especially in early life?

One researcher who has been exploring these topics, both literally and figuratively, is Dr. Nalini Nadkarni, now a professor in the Department of Biology at the University of Utah (Figure 1). Dr. Nadkarni has spent much of the last forty years hundreds of feet above the ground, studying the ecosystems of the canopies of the trees in cloud forests. Knowledge obtained from Dr. Nadkarni's work has advanced the science of forest ecosystems; beyond this highly cited and pioneering research, Dr. Nadkarni has garnished international headlines for her work that has drawn upon the diverse lessons learned about the fragility and resilience of forest ecosystems, equity and opportunity, human connections to nature, and the importance of breaking down silos in science and medicine.



Figure 1. Nalini Nadkarni in her University of Utah office, where she is a professor of biology. Photo credit: Benj Drummond.

For decades, Dr. Nadkarni has prioritized science communication through public engagement; she has worked with elementary school students, artisans, corporations, prison wardens and people who are incarcerated, musicians, and diverse spiritual groups, to promote knowledge of the Earth's natural ecosystems, and the importance of plant life. *Challenges* was honored that Dr. Nadkarni agreed to be the subject of the journal's ongoing Nova spotlight interviews.

2. The Nova Interview

Nova: We have set the table here by discussing the development of psychological connections to nature—nature-relatedness—in early life. If you look back to your childhood, can you see a line between your own early life nature experiences and the work you do today?

Dr Nadkarni: In retrospect, I see very clear lines that link my scientific and professional activities with my early-life nature experiences. First, my family was of mixed cultures—my dad was from India, a Hindu, and a scientist. My mom was the daughter of immigrants from Russia, an Orthodox Jew, and a language teacher. We learned that interweaving different religions, traditions, and cultures was something simple and positive. As with many ecologists (and scientists!), I developed a strong connection to trees when I climbed the eight maple trees in our front yard after school (Figure 2). It was something only I (of the five siblings) did, and that early link to trees—and other elements of nature—instilled a desire very early on that I wanted to do something that would help and protect trees when I became a grown up. I could only imagine being a firefighter or a park ranger, but when I went to college, I discovered the world of ecology, which led to my decision to be an ecologist who understands trees and incites conservation of forests.



Figure 2. Nalini Nadkarni as a young child who loved to climb trees after school. Photo Credit: Moreshwar Nadkarni.

Nova: You started your undergraduate academic pathway at Brown University with a dual major, one in the arts and the other in the sciences. Can you tell us a little bit about that, and whether it shaped your current perspectives on science communication?

Dr Nadkarni: Throughout my youth, I was interested in both field biology and modern dance. I took dance lessons starting when I was four years old, and continued through college. I was fortunate to be in one of the first classes at Brown University who experienced the “New Curriculum,” which emphasized student-generated learning,

and exposure to multiple disciplines and ways of knowing. There were no distribution requirements, and interdisciplinary seminars were offered to freshmen. Although my emphasis was on biology/ecology, I was also allowed to transfer during my junior year to the Forestry School at the University of British Columbia, where I took classes in traditional forestry (not available at Brown). And I took classes in the modern dance department and performed with the senior class troupe, which, coupled with my training in the sciences, provided me with different ways of understanding and communicating ideas to others. I believe that set the stage—and in some ways—provided the “permission” for the work I have subsequently done to weave together the sciences with the arts and humanities.

Nova: Writing in the Bulletin of the Entomological Society of America in 1983, Dr. Terry L. Erwin of the Smithsonian Museum referred to the rainforest canopy as the “last biotic frontier” [18]. Dr Erwin’s paper contained very few references, and in the manuscript, he acknowledged that techniques to gather data at the canopy level were limited. That same year you earned your PhD exploring that very frontier. Why were you motivated to go up into this uncharted territory?

Dr Nadkarni: The reason I first wished to go to graduate school was that I wanted to learn about how to grow trees for tropical reforestation. Immediately after college, I spent a year working as a field assistant for an entomologist in a remote field station in Papua New Guinea. There, forestry and gold mining were taking a toll on the primary rainforests, and I saw first-hand the destruction that was occurring and the need for reforestation. I was accepted into a masters program in the College of Forest Resources at the University of Washington, and during my first year there, I took an 8-week graduate course in tropical biology through the Organization for Tropical Studies. It was there that I first visited a cloud forest, and looked into the canopy to see orchids, bromeliads, ferns, monkeys, and birds living high above the forest floor. When I asked about what the canopy plants are DOING—how they function within the forest—my professors had almost no insights—scientists had simply never explored the forest canopy from a research standpoint because of the lack of safe and non-destructive access techniques. I felt at that time it was important to get UP there, to not just wait for canopy plants to fall, but to study them in their own canopy habitat, much like marine biologists found they needed to invent SCUBA gear to study marine life where it occurs (Figure 3).

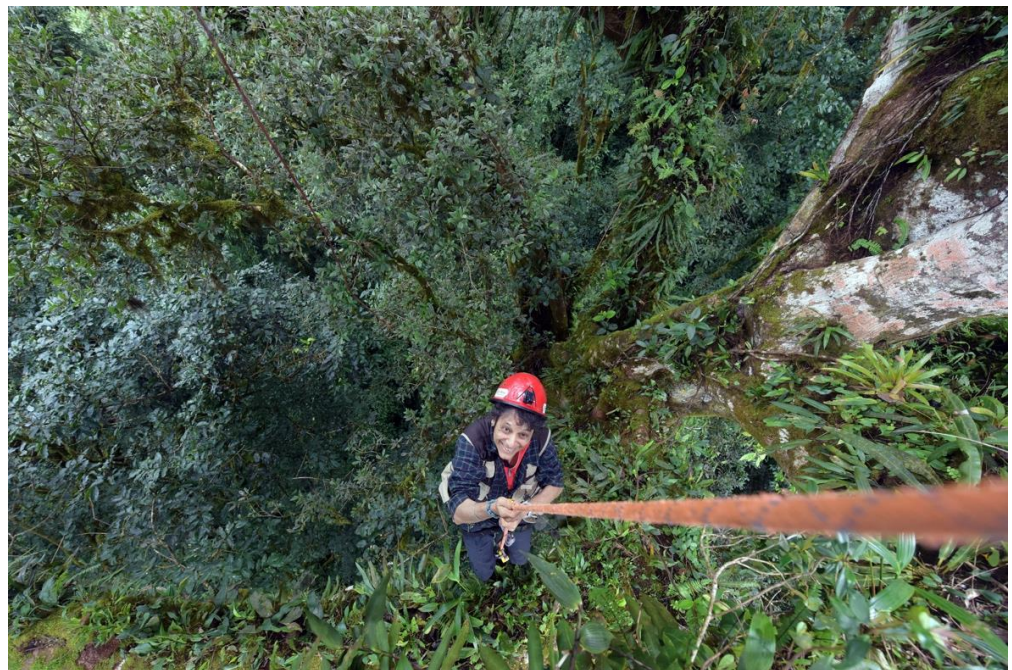


Figure 3. Nalini Nadkarni ascending a tall rainforest tree in Monteverde, Costa Rica, for her canopy research. Photo credit: Sybil Gotsch.

I happened to encounter a graduate student named Don Perry when I passed through a field station on that course. He was using mountain-climbing gear to scale tall tropical trees to document pollination biology of trees, and I convinced him to teach me how to climb, which he did! I spent some time on his canopy platform, 125 feet above the ground, and witnessed the abundance and diversity and vitality of canopy life. When I returned to my graduate committee with my plans to return to the tropics to study canopy ecology, they were not enthused. I pointed to Terry Erwin's statement about "the last biotic frontier," in an effort to show them that the canopy was a place ripe for discovery. I ended up writing my own grant proposal (to UNESCO's Man and the Biosphere program, for \$50,000, a huge amount for a grad student at that time), so I was able to fund my own research. I made some discoveries that were consequential (ending up on the cover of *Science*), and that started my career as a canopy researcher.

Nova: At that time ecologists often worked alone, as you did in the cloud forest canopy. That is interesting because the subject under scrutiny was, and often is, diverse interconnected systems teeming with life. Is it still that way now, or do you think there is more collaboration?

Dr. Nadkarni: As a graduate student in the early 1980s, it was common, if not required, that graduate students (and many junior researchers) work alone, to "prove" that the person is capable of independent research. So, I did my dissertation work and my early-career work pretty much single-handed. I even climbed alone for whole days in the forest, which makes me cringe now, since that is so patently dangerous! In the current time, collaborative work is much more the norm, and it is actually quite rare of an ecologist to carry out a study on his/her own. To me, especially in the field of ecology, collaboration makes excellent sense, as there are so many complex interactions between organisms and their environments that it is virtually impossible for one person alone to have expertise in all of the fields needed to document patterns, explain processes, and make predictions.

Nova: You and your husband (Jack Longino, an ant taxonomist) took faculty jobs at Evergreen State College in Olympia, Washington. Evergreen is well-known as a progressive liberal arts college that prioritizes interdisciplinary studies and collaborative learning. Forbes magazine, which uses metrics such as alumni income and whether alumni are the "richest self-made" entrepreneurs, doesn't think much of Evergreen in its annual college rankings [19]. Yet, by some metrics Evergreen is highly ranked in the United States. In 2022, Evergreen's graduate program was ranked #1 in the United States for public good (by Washington Monthly) based on three broad categories: social mobility, research and promoting public service [20]. In an accompanying editorial, Washington Monthly argues that some of the best colleges and universities are elided by elite media and are absent from popular culture [21]. Do you think Evergreen College shaped the way you approach teaching, research, and science communication?

Dr. Nadkarni: The Evergreen State College and its foundational philosophy of pursuing interdisciplinary ways of learning and teaching to understand the world and solve problems had a huge effect on the way I approach my studies and my life. Having come from my first position at a traditional R1 university (University of California Santa Barbara), a highly silo'd institution, it was a shock and a pleasure and a revelation to co-teach and do research with people outside my field—not just other scientists, but with artists, humanists, policy experts, and social scientists. At first, I balked at this seemingly "non-rigorous" way of teaching, but within a few years, I learned how much more my students and I were taking in when we were guided to look at a particular topic, habitat, or interaction through multiple lenses.

In addition, Evergreen emphasized teaching over disciplinary research. Because my husband and I chose to split a single faculty position, we were able to teach half-time, which allowed us to do research (mostly in Costa Rica) and raise our two kids in ways that we would not have been able to if we both had full teaching positions. We had to watch our finances, since Evergreen paid very poorly, and we only had the one salary, but it provided

freedom to pursue exciting teaching and to have time to get NSF and National Geographic grants and spend time in the field, in Costa Rica.

Also, because Evergreen had a philosophy against elitism and privilege, even among its own faculty, everyone was a “Member of the Faculty” and there was no faculty rank or tenure, so I was free to pursue other avenues—such as public engagement about trees and forest conservation with non-academic groups such as faith-based congregations, people who are incarcerated, artists, and corporations. I not only had the freedom to spend the time building these relationships and the capacity to engage with them, but also, I had “permission” from my fellow faculty and administrators there, who thought that such work had merit. It would have been difficult if not impossible to carry out those programs in a standard R1 institution.

What is really interesting to me is that currently, many R1 universities are desperately trying to foster interdisciplinary scholarship—and the NSF is championing and placing a LOT of funding toward what they call “convergence research” (interdisciplinary and transdisciplinary research), which is what Evergreen and its faculty have been doing for over 50 years. I have found that now that I am in the milieu of an R1 university (University of Utah, School of Biological Sciences), my ability to think and act across disciplines, and to engage with non-academic groups is totally in demand! I am invited to give keynote talks at major conferences, seminars at other universities, and presentations on panels (this week, at the United Nations Summit on Science). They are interested in my canopy research, but much more, they want to hear about how to think across disciplines and interact with community groups. And Evergreen gave me those skills and those approaches.

I have followed many Evergreen graduates through their careers after graduation, and I have found them to be successful—perhaps not huge money-makers, like my fellow undergraduates at Brown University—but successful in finding ways to contribute to the environment and society, to be aware and take actions for social justice, and to have a sense of the importance of a balanced, healthy life that involves building and sustaining community. So, I agree that Evergreen is a place where training in different ways than the norm is helping to create a more thoughtful and wholistic-thinking society.

Nova: On the note of liberal arts degrees, there has been a recent push to emphasize a richer background in the arts and humanities among medical school candidates. McMaster University, in Ontario, Canada, for example, does not require pre-med or an undergraduate degree in the sciences. Even their use of the MCAT as an evaluative tool is limited to scores on critical appraisal and reasoning sections only. How do you feel about this? After your own personal injuries from a serious canopy fall, you have spoken and written quite a bit about the healthcare system. How can we bring empathy into healthcare and shift the environment in hospitals to emphasize healing?

Dr. Nadkarni: I believe that training in all professions should present an open approach to what is needed and valuable to its practice, and medicine is not an exception. Understanding the underlying patterns and processes of what constitutes health and illness goes beyond only knowing the mechanics of tendon attachment or capillary response to medication. Analogously, those who focus their studies on the humanities and arts would benefit from respectful exposure to the sciences, engineering, and medicine.

Obviously, it behooves each type of training to ensure that its practitioners have a sufficient depth of understanding in that discipline to gain the capacity to accomplish the tasks and have the insights needed to treat a patient or write a sonnet or create a painting. When I taught science at The Evergreen State College, which had a very broad “openness” to interweaving different ways of knowing, I sometimes worried that our science-oriented students did not gain the needed depth in chemistry, math, or statistics to contribute to their future scientific endeavors. However, that occasional lack of depth was balanced by their skills in understanding *how* to gain more knowledge, and also to appreciate other ways of understanding the world, e.g., intuitive, indigenous, or spiritual ways of knowing.

In my own experience with the medical world—which was precipitated by a 50-foot-high fall from the top of a tree when I was doing canopy research in 2015—I was able to

observe the medical profession in a very personal way. I was impressed both by the depth of knowledge that physicians had at hand to treat my many traumatic injuries, and also—in general—by the one-dimensional way that they viewed me, as the “spinal fusion” or the “lacerated lung”. However, my experiences and interactions of my recovery as a whole were populated by many people—nurses, therapists, the hospital chaplain—who clearly viewed me as a person and not just a collection of broken bones.

Since my fall, I have been invited to give presentations in the Grand Rounds of medical schools, at critical care medicine and nurses’ conventions, and to write articles for medical journals about trauma recovery “from the patient’s point of view.” I have also been invited to participate in the writing of planning and vision documents for the “future of critical care medicine” by the Society of Critical Care Medicine. I find this remarkable, as inviting a totally non-medical expert into the forecasting for a medical field seems extremely open-minded and demonstrates respect for input from those outside the field. In that capacity, I have felt the importance of my participation to be a spokesperson for inclusion of family and friends at the bedside of intensive care unit patients. I’m also advocating for the intentional inclusion of more elements of nature in the hospital (especially the intensive care units), as nature is almost entirely lacking in those environments, and would help to reduce stress and anxiety on the part of the patient, his/her visitors, and the medical professionals who spend time in those nature-deficit environments.

During and after my medical experiences, it has remained a puzzle about the extent to which empathy should and can be emphasized. On the one hand, we want our caregiver to care about patients as individuals, and not simply “the spinal fusion.” On the other hand, healthcare workers must—to some extent—protect their own hearts and sensibilities from the duress of not being able to fix every injury or illness of their patients, as that would be impossible for a human being to bear.

That concept makes me think about my own fieldwork in tropical forests. For some of the questions I pose (e.g., what is the biomass of canopy-dwelling plants in a primary versus secondary forest?), I must use destructive techniques of cutting off and weighing whole branches, or even felling whole trees. I feel empathy for the living thing I am killing, to be sure, but I am also able to carry out such actions, as I am convinced that those actions will lead to a greater understanding of the forest and lead, ultimately, to more informed forest management decisions. So, perhaps like medical doctors, I give myself some “space” to suspend my sense of empathy when I believe it is justified.

Nova: The grand challenges faced by humanity—climate change, biodiversity losses, poverty, mass incarceration, early mortality from non-communicable diseases, health inequalities, social injustices, violence, the spread of ultra-processed foods, consumerism, for example—are intertwined and will not be solved by isolated, linear thinking. Can you tell us a little bit about your concept of tapestry thinking, and its application to health at scales of person, place and planet?

Dr. Nadkarni: Perhaps because of my mixed cultural family background, or my earlier higher education experiences of the New Curriculum at Brown University, or my 20 years of faculty experience at The Evergreen State College, I have long recognized that many questions and problems might (or must) best be addressed through multiple disciplines and ways of knowing. However, I’ve also recognized that there are many ways to approach interdisciplinary thinking.

One can take bright red paint and white paint and mix them to get pink paint, but one loses the purity and depth of the original colors. One can take also different objects (like different colored jellybeans) and put them together in a bowl and consider them “mixed.” But they are not actually integrated, and can be easily re-separated. One can also cut up pieces of things and mix them together, like a tossed salad, and apply a single, unifying dressing on them, and consider that “mixed,” but the elements can still be distinguished and separated. One can mix up two different malleable elements in a container (like those awful jars of Smuckers peanut butter and jelly), and that can result in a true mixing, but with a loss of the “purity” of elements, which cannot then be re-extracted. And finally,

one can mix things together in a way that will create a completely different entity that ultimately shares nothing in common with the initial constituents, like mixing yeast, flour, and mild together to bake bread.

My most successful approach to attempt to solve difficult problems with an interdisciplinary framing is to use a different model or metaphor—a tapestry—something complex, connected, strong, useful, and beautiful. I start with a loom—which might be an institution, an organization, a department, a program, or a group of people—upon which I can attach the “threads” of different ways of knowing, values, or actions. Each of these has a metaphorically different color and texture, but with forethought and time, the weaver can intertwine these elements to make a new image. And the key is that each of the different colored/textured entities remains true to itself. It is not a blending or a loss of the deep contribution that each thread provides, but rather a complementary and creative strengthening of all of the threads.

For example, when I brought my threads of science and conservation of trees to religious communities, and wove these ideas into the congregants’ beliefs that God created trees and they are therefore sacred, one of the outcomes—the tapestry of care for trees—was that we participated in a joint tree-planting on the grounds of the church in which I engaged. Those efforts drew upon the very different threads of science and faith, but the resulting tapestry was a set of actions that benefitted trees and all who participated. Neither group felt “blended” or erased.

Nova: Before we go any further, let’s get to Barbie, the world-famous doll manufactured by the Mattel Corporation. You made international headlines in late 2019 and early 2020 when Mattel announced a collaboration with National Geographic to produce a line of STEM-positive Barbie dolls known as Explorer Barbie. It has been widely reported that you were part of an advisory group that helped to design those dolls [22,23]. However, less well-known is the backstory that almost 20 years earlier you had gone rogue and were retrofitting Barbie dolls with tailored clothes and tree-climbing gear as part of your own communications strategy to both break down some of the stereotypes associated with the typical Barbie, and promote a love of trees among young girls [24]. Those activities caught the attention of the New York Times in 2003 [25], which, in turn, caught the attention of the toy corporation. Is it true that this early effort caused some conflict with Mattel?

Dr. Nadkarni: My efforts to provide inspiration and guidance for young girls (and maybe boys) to appreciate and possibly pursue a profession that involves exploration and field science has had a long and mixed history. In my early efforts to carry out effective public engagement of people with trees, I recalled that my own strong connection to trees and forests was established when I was a little girl who loved climbing trees in my front yard. But I realized that many young people (especially those in dense urban habitats) don’t have access or models to climb trees or engage with nature. At that time, my own 7-year-old daughter was expressing interests in our getting her a Barbie doll (to my horror!), and I realized that many young girls want and respect Barbies. That morphed into the idea of creating a “TreeTop Barbie,” with field clothes, a helmet, a crossbow (to shoot the initial line up a tree) and an accompanying booklet about canopy-dwelling plants.

I called Mattel, offering the idea (for free), and letting them know that many parents (like me) would be open to buying such a Barbie (rather than a prom-ish oriented doll). They refused the idea, stating that their corporation designs their own Barbies. My lab students and I persisted with the concept by buying used Barbies, stripping her clothes off, and dressing her in field clothes that were sewn for us by volunteer seamstresses. We made our own booklet about canopy plants, bought little helmets and crossbows on e-bay, and made them available on my small, academic website.

I also began bringing TreeTop Barbie to scientific meetings, and when I gave presentations to my peers, I would discuss the importance of stepping outside our little academic bubble to make an effort to communicate with non-academics through media that have

meaning and value to these other audiences. At one of those meetings, a New York Times reporter was present, and she wrote this up as an article in *the Science Times*.

That alerted the lawyers at Mattel, who called me and told me that I must shut down these actions because they infringed on their brand. I offered (again) to give them the idea, which they declined. I told them that I know quite a few journalists who would be interested in the story that Mattel was shutting down the efforts of a scientist of color who was trying to inspire young girls to become field scientists. After some corporate consultation, they called back and said that they could give me oral (not written) permission to continue, as long as the operation remained small.

Fifteen years later, I got a call from the National Geographic Society. They had partnered with Mattel to create a line of “Explorer Barbies” (polar explorer, astrophysicist, entomologist, nature photographer, wildlife biologist) and asked me to advise them, for which they made a one-of-a-kind Nalini lookalike Barbie, which I now have in my lab (Figure 4). I was delighted to know that Mattel took this on, but I don’t think it is as much a reflection on Mattel as it is on the fact that society has changed sufficiently since my first attempt in 2003—in that now there are many, many more young girls who want to have a Barbie that is concerned with understanding and protecting the Earth, rather than just wanting to acquire the right accessories for the prom.



Figure 4. Nalini Nadkarni showing the “TreeTop Barbie” that the Mattel corporation and the National Geographic Society created to inspire young children to explore nature and contribute to and appreciate science. Photo credit: Hayley Jackson.

Nova: In 2014 *Time* magazine announced their annual 25 ‘best inventions’ of the year. Lumped in with the selfie-stick (which now seems obsolete!), the Apple Watch, a working ‘hover board’, and other gadgets, was the ‘Blue Room’, described as the room that helps inmates relax [26]. *Time* was referring to your work at a correctional facility in Oregon [27]. Specifically, you designed a space for inmates in segregated housing, a term that is often used synonymously with solitary confinement. Essentially, through

dynamic imagery you were able to bring the visual aspects of nature (moving scenes of diverse outdoor natural environments) into one of the most isolated places on planet Earth, and to one of the most vulnerable groups of humans. How did that project get started?

Dr. Nadkarni: In 2003, I began efforts to bring science education and nature access to one of the most education- and nature-deficient groups in our country: adults and youth who are incarcerated in state prisons, county jails, and juvenile detention centers. It seemed important to me to not only raise awareness of the importance of understanding and conserving nature to those who have access to science education and participation in ecological restoration work in traditional venues (such as museums, zoos, botanical gardens), but even more so to those who do not or cannot gain access to these because of legal, financial, or cultural barriers. It seemed to me also that those who are incarcerated in carceral facilities would be the most likely to benefit from such work, as the environments in which they live and work are almost totally lacking in nature, and because psychological research has demonstrated that access to nature—or even nature imagery—can reduce stress, anxiety, and violence, as well as providing a sense of contribution to something bigger than oneself or one’s immediate surroundings.

For several years, the program I co-established with a prison superintendent in Washington State, The Sustainability in Prisons Program, brought science lectures and participation in hands-on conservation projects (such as rearing endangered species like the Oregon Spotted Frog and the Taylor Checkerspot Butterfly, and building nest boxes for declining bird species) was made available to minimum- and medium-security people who are incarcerated in many state prisons. However, I soon realized that we were not providing similar access to education and conservation to those who are sequestered most deeply in the US system of incarceration—the cellblocks for solitary confinement (“intensive management units,” “segregated housing”). I knew that I could not bring plants, soil, animals, or even lectures to those spaces due to high security levels.

Because providing nature imagery to these cellblocks would not incur the same issues as bringing in real biota, I suggested this as an intervention that might connect the incarcerated people with nature and the outdoors, and confer at least some of the same emotional benefits as engaging with real nature. I was successful in convincing administrators of the potentially positive aspects, but I encountered a great deal of resistance from the officers, who felt that “making the men feel calmer” was not part of their job nor the mission of the prison system.

I was invited to give a TED talk in 2010, and discussed this as a possibility, but had to state that I was not able to test this out. Two years later, I got a phone call from a correctional officer who worked at a Supermax prison in Oregon. He had seen my TED talk and wanted to know if it would work. I told him I had never been able to find a prison where I could try this approach out, and he responded with a profound statement that revealed to me a key element of how I now approach public engagement of science. He said that if this DID work, and violent incidents were reduced because of the intervention, it would make the prison safer and better not only for the inmates, but also for the officers who are charged with their oversight. And if that were the case, then it would be considered a benefit and of value to the officers and administrators. I realized that I had been imposing my own values (connecting people without connection to nature, to nature) rather than thinking about the values and needs of the people inside the very system I was trying to work with.

When we framed it that way, the officer set up a “Forward-Thinking Committee” at his prison, consisting of officers, the behavioral specialist, and the Superintendent, and I participated as an advisor. My team and I received a grant from the National Geographic Society, and I got the protocol design, surveys, and other project aspects approved by the Institutional Review Board at the University of Utah, which provides ethical oversight for research that involves “vulnerable” populations (such as the incarcerated).

We were given access to a solitary confinement cellblock that was divided in two parts, with the same control room, same officers, and inmates with similar risk factors. In the

exercise room on one side, we installed a projector and provided 38 nature videos, from which inmates could select to view while spending their hour-a-day in the exercise room. On the other side of the cellblock, we did not show videos. After one year, we carried out interviews and surveys of the inmates and the officers, and found that inmates felt more connected to nature, had better relationships with the officers, and felt calmer. In examining their records for that time, we learned that the men who watched nature videos committed 26% fewer violent infractions than did the men on the other side of the cellblock. In addition, the officers began paying closer attention to the men, and saw that if they observed “precursor” behaviors towards violence, they would offer extra time in “the Blue Room” (they called it the Blue Room because they learned that the color blue is the most calming color, and so they painted the walls of the exercise room with nature videos blue). This appeared to deflect and prevent violent outbreaks before they occurred.

Nova: Your effort to bring nature into solitary confinement is not without critics. Some say that improving the conditions afforded to inmates during one hour of time outside an extremely small cell is a way for prison authorities to justify an otherwise unacceptable practice [28]. The social work profession, members of which provide counseling services in segregated housing units, have also engaged in deep debate about the ethics of contributing to the practice. How would you respond to these concerns?

Dr. Nadkarni: I definitely understand the concerns of critics and social workers about this intervention. I can see how this practice might be interpreted as justifying or mitigating the many negative impacts of isolating humans in tiny, natureless cubicles. I have sustained my own concerns about these very same issues.

However, I have also worked with the system of state prisons and correctional institutions for nearly 20 years, and I do not see the system of incarceration as going away, even though it is filled with injustice and many of its outcomes creates more harm to more individuals than it rehabilitates. Therefore, my approach has been to put forward efforts that might improve the immediate lives of those who are already inside the system, and who currently suffer not only the isolation from family, having a job that contributes to society, lack of education, and demoralizing social hierarchical interactions, but also from lack of contact from nature. I have also heard from and carried out formal evaluation of the people who have viewed our nature videos and those who have been involved with our lecture series and our conservation projects, and their responses have been positive. I feel that if I and other academics and conservationists can help with restoring connection to the stimulation of minds and connections to nature, then we should do that. However, I am open to discussing the pros and cons of all of these practices with others.

Nova: More recently you have focused on at-risk youth. How does your work with the STEM Community Alliance Program bring science education to Youth in Custody?

Dr. Nadkarni: In 2017, I was approached by the Utah State Board of Education (USBE) to initiate a program that would provide the same resources as we provide for adults who are incarcerated to youth-in-custody (YIC) in the state of Utah. We began the STEM Community Alliance Program (STEMCAP) in five juvenile detention centers in Salt Lake Valley to augment the science educational offerings that these youth receive in their education (all YIC are provided standard education inside these facilities until they are 18). We began with science lectures, offered by faculty and graduate students I recruited from the University of Utah, in which a researcher would provide a lecture and readings and Q&A for youth inside one or more of these facilities (Figure 5).



Figure 5. Nalini Nadkarni giving a lecture on tree conservation to people who are incarcerated at the Utah State Prison, in Salt Lake City. Photo Credit: Jana Cunningham.

In subsequent years, we added art-science workshops, as we found that many of these youth have had negative experiences with science education, and are more open to having art, poetry, or the humanities as a “Portal” to science. So we pair a scientist (e.g., an atmospheric scientist who studies cloud chemistry) with a watercolor artist (who teaches the students to make water color images of clouds). We also offer “Objects from Nature” workshops, in which we bring in collections of paleo bones or feathers or sea shells for the students to handle and ask questions about. And we provide “virtual lab tours,” in which we provide a remote tour of a biology or physics lab, introducing them to the professor, graduate students, and undergraduate assistants, with the intention of showing the YIC that there is a place in which they can feel comfortable in a higher education environment. We’ve also carried out hands-on conservation projects, such as having the YIC grow milkweed plants that are then outplanted in “way stations” to improve habitat for migrating Monarch butterflies, which are in alarming decline across North America. We put out signs at those waystations so that community members can see that YIC living in juvenile detention centers can and do contribute to conservation. Our most recent addition has been to provide undergraduate student “pen-pals” with individual YIC, to both show YIC that college students are cool and real and care about YIC, and for undergraduates to know that YIC are interested in learning and science, and not just juvenile delinquents that might be written off as failures.

We are now writing up our approaches, protocols, and practices so that other academics who might want to start a similar program in their own communities benefit from the lessons we have learned.

Nova: It is remarkable to consider your work holistically. When you first climbed those ropes hundreds of feet into the canopy, a frightening concept for many humans, you were beginning a journey that would, years later, challenge institutions that are stubborn and classically resistant to change—corporations and correctional systems. In a way, these institutions maintain their own ‘ecosystems’, and they may not always operate in ways that promote health. Do you see your work as providing a sense of hope? When you are approached by young students, let’s say elementary students through undergraduate level, what are some of the more common reactions to your work?

Dr. Nadkarni: Although my research touches on extremely severe environmental challenges that might foster despair—deforestation, climate change, forest fragmentation, distancing of humans from nature—I think that any work that tries to address them can be viewed as inherently hopeful. Sometimes, when I reflect on the number of trees and

people that my research and public engagement work has affected, I get very sad, because of the smallness of that number, and the largeness of the numbers that still need protecting (trees) and connecting (people to nature). I have to resist letting that sadness render me indifferent or immobile, because that is a sure path to despair and incapacity.

I am then prompted to think of my work not as an ultimate solution, but rather as an example of what one person, one scientist, one communicator can do. I'm not even sure I can say that I provide a model for others, since I have had such a unique career and personal trajectory. But I think that others can look to what I've been able to do within a fairly restricted profession—academic science—and realize that it is possible to step outside the boundaries that are typically set for an academic, and proceed to forge collaborations and partnerships, find support and funding, and gain the ears of people that range from prison wardens to rap singers to the Archbishop of Canterbury. In that way, I believe my actions can be seen as a small song of hope in the cacophony of terrible environmental and social problems that surround us.

When I speak to younger people—from elementary school to undergraduates, I find that they are most receptive to the idea that we need not be restricted to the place we work, the gender we exhibit, or the color of our skin. A woman of color with an oddball name can knock on the doors of universities, state prisons, slam poetry competitions, corporate boardrooms, and Jesuit churches, and be welcomed, if she is willing to approach these groups with intellectual humility and a genuine desire to seek and learn from other ways of knowing. I have also discovered that in nearly every audience I've encountered, there is a remarkably strong desire to contribute to solving these problems, to creatively and fearlessly want to make the world better for elements of nature (like trees!) and for humans. I almost always come away from engaging with young people with a greater sense of hope.

Nova: In 1988, OMNI magazine asked well-known personalities, some in science and medicine, about their own utopian thinking, or the world they would like to live in. Contemporary research on utopian thinking indicates that it can be a healthy process, increasing both personal and social hope, yielding an abstract mindset that bridges the psychological distance between the status quo (“here and now”) and a better possible future:

What type of world would you like to live in?

Dr. Nadkarni: Your question reminded me of a poem by Lawrence Ferlinghetti that I choreographed a modern dance to when I was a senior at Brown University. Below are a few of the lines that articulate a description of the world I would like to live in.

*I am waiting
for a rebirth of wonder
I am waiting
to get some intimations
of immortality
by recollecting my early childhood
and I am waiting
for the green mornings to come again
I am waiting
for forests and animals
to reclaim the earth as theirs
and I am awaiting
perpetually and forever
a renaissance of wonder.*

Lawrence Ferlinghetti, “I Am Waiting” from *A Coney Island of the Mind*, 1958

Author Contributions: A.C.L. prepared the questions and background research and conducted the interview. N.M.N. provided intellectual content and reviewed and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Logan, A.C.; Langevin, H.M. Spotlight: An Interview with NCCIH Director, Dr. Helene, M. Langevin, on Whole Person Health. *Challenges* **2022**, *13*, 42. [CrossRef]
2. Nieuwenhuijsen, M.J.; Dadvand, P.; Márquez, S.; Bartoll, X.; Barboza, E.P.; Cirach, M.; Borrell, C.; Zijlema, W.L. The evaluation of the 3–30–300 green space rule and mental health. *Environ. Res.* **2022**, *215*, 114387. [CrossRef]
3. Methorst, J.; Bonn, A.; Marselle, M.R.; Böhning-Gaese, K.; Rehdanz, K. Species richness is positively related to mental health—A study for Germany. *Landsc. Urban Plan.* **2021**, *211*, 104084. [CrossRef]
4. Mellor, C.; Botchway, S.; Barnes, N.; Gandy, S. Seeding hope: Restoring nature to restore ourselves. Nature restoration as an essential mental health intervention. *Int. Rev. Psychiatry* **2022**, *34*, 541–545. [CrossRef]
5. Oh, R.R.Y.; Fielding, K.S.; Chang, C.C.; Nghiem, L.T.P.; Tan, C.L.Y.; Quazi, S.A.; Shanahan, D.F.; Gaston, K.J.; Carrasco, R.L.; Fuller, R.A. Health and Wellbeing Benefits from Nature Experiences in Tropical Settings Depend on Strength of Connection to Nature. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10149. [CrossRef] [PubMed]
6. Richardson, M.; Hamlin, I.; Elliott, L.R.; White, M.P. Country-level factors in a failing relationship with nature: Nature connectedness as a key metric for a sustainable future. *Ambio* **2022**, *51*, 2201–2213. [CrossRef] [PubMed]
7. Li, D.; Zhai, Y.; Chang, P.-J.; Merrill, J.; Browning, M.; Sullivan, W.C. Nature deficit and senses: Relationships among childhood nature exposure and adulthood sensory profiles, creativity, and nature relatedness. *Landsc. Urban Plan.* **2022**, *226*, 104489. [CrossRef]
8. Bashan, D.; Colléony, A.; Shwartz, A. Urban versus rural? The effects of residential status on species identification skills and connection to nature. *People Nat.* **2021**, *3*, 347–358. [CrossRef]
9. Oh, R.R.Y.; Fielding, K.S.; Nghiem, L.T.P.; Chang, C.C.; Carrasco, R.L.; Fuller, R.A. Connection to nature is predicted by family values, social norms and personal experiences of nature. *Glob. Ecol. Conserv.* **2021**, *28*, e01632. [CrossRef]
10. Sun, Y.; Wang, X.; Zhu, J.; Chen, L.; Jia, Y.; Lawrence, J.M.; Jiang, L.H.; Xie, X.; Wu, J. Using machine learning to examine street green space types at a high spatial resolution: Application in Los Angeles County on socioeconomic disparities in exposure. *Sci. Total Environ.* **2021**, *787*, 147653. [CrossRef] [PubMed]
11. Alderton, A.; O'Connor, M.; Badland, H.; Gunn, L.; Boulangé, C.; Villanueva, K. Access to and Quality of Neighbourhood Public Open Space and Children's Mental Health Outcomes: Evidence from Population Linked Data across Eight Australian Capital Cities. *Int. J. Environ. Res. Public Health* **2022**, *19*, 6780. [CrossRef] [PubMed]
12. Rigolon, A.; Browning, M.H.E.M.; McAnirlin, O.; Yoon, H.V. Green Space and Health Equity: A Systematic Review on the Potential of Green Space to Reduce Health Disparities. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2563. [CrossRef] [PubMed]
13. Hong, A.; Martinez, L.; Patino, J.E.; Duque, J.C.; Rahimi, K. Neighbourhood green space and health disparities in the global South: Evidence from Cali, Colombia. *Health Place* **2021**, *72*, 102690. [CrossRef] [PubMed]
14. Passmore, H.; Martin, L.; Richardson, M.; White, M.; Hunt, A.; Pahl, S. Parental/Guardians' Connection to Nature Better Predicts Children's Nature Connectedness than Visits or Area-Level Characteristics. *Ecopsychology* **2021**, *13*, 103–113. [CrossRef]
15. Yang, Y.; Hu, J.; Jing, F.; Nguyen, B. From Awe to Ecological Behavior: The Mediating Role of Connectedness to Nature. *Sustainability* **2018**, *10*, 2477. [CrossRef]
16. Baxter, D.E.; Pelletier, L.G. Is nature relatedness a basic human psychological need? A critical examination of the extant literature. *Can. Psychol.* **2019**, *60*, 21–34. [CrossRef]
17. Hurly, J.; Walker, G.J. Nature in our lives: Examining the human need for nature relatedness as a basic psychological need. *J. Leis. Res.* **2019**, *50*, 290–310. [CrossRef]
18. Erwin, T.L. Tropical Forest Canopies: The Last Biotic Frontier. *Bull. Entomol. Soc. Am.* **1983**, *29*, 14–20. [CrossRef]
19. Whitford, E.; Howard, C. America's Top Colleges. Forbes. Available online: <https://www.forbes.com/colleges/the-evergreen-state-college/?sh=40c8c7a75c72> (accessed on 29 September 2022).
20. Washington Monthly. 2022 College Rankings. Available online: <https://www.nxtbook.com/nxtbooks/washingtonmonthly/20220910/> (accessed on 30 September 2022).
21. Carey, K. America needs a new definition of higher education excellence, one that measures what colleges do for their country, instead of for themselves. *Wash. Mon.* **2022**, *54*, 15–17.
22. Khanna, M. Scientist Nalini Nadkarni Has Inspired Her Own Barbie, And We Should All Be Proud of Her. India Times 5 January 2020. Available online: <https://www.indiatimes.com/technology/news/this-indian-origin-scientist-inspired-her-own-barbie-and-we-should-all-be-proud-of-this-503608.html> (accessed on 30 September 2022).
23. Free, C. She Started Climbing Trees as a Kid. Then This Ecologist Helped Create Scientist Barbie. Washington Post. 17 January 2020. Available online: <https://www.washingtonpost.com/lifestyle/2020/01/17/she-started-climbing-trees-kid-then-this-ecologist-helped-create-scientist-barbie/> (accessed on 29 September 2022).
24. Sofia, M.K.; Stern, M.; Harlan, B. Tree Scientist Inspires Next Generation ... Through Barbie. National Public Radio 18 October 2019. Available online: <https://www.npr.org/2019/09/22/762385293/video-tree-scientist-inspires-next-generation-through-barbie> (accessed on 30 September 2022).

25. Yoon, C.K. Making Science Rock, Roll and Swing from the Treetops. New York Times. 23 September 2003. Available online: <https://www.nytimes.com/2003/09/23/science/making-science-rock-roll-and-swing-from-the-treetops.html> (accessed on 29 September 2022).
26. Time Staff. The 25 Best Inventions of 2014. 20 November 2014. Available online: <https://time.com/3594971/the-25-best-inventions-of-2014/> (accessed on 30 September 2022).
27. Nadkarni, N.M.; Hasbach, P.H.; Thys, T.; Crockett, E.G.; Schnacker, L. Impacts of nature imagery on people in severely nature-deprived environments. *Front. Ecol. Environ.* **2017**, *15*, 395–403. [CrossRef]
28. Popkin, G. Nature Videos Help to Calm Inmates in Solitary Confinement. 1 September 2017. Available online: <https://www.scientificamerican.com/article/nature-videos-help-to-calm-inmates-in-solitary-confinement/> (accessed on 30 September 2022).