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Health Forest Networks: A Unified Urban Response to Regional Ecosystem Degradation and the Rise of Chronic Disease

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HEALTH FOREST NETWORKS: A UNIFIED URBAN RESPONSE TO REGIONAL ECOSYSTEM DEGRADATION AND THE RISE OF CHRONIC DISEASE

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Scientists and world leaders are sounding alarm bells about the rate of global ecosystem degradation and associated climate change, as well as the rapidly increasing public health burden of chronic diseases. This Article, primarily focused on United States cities, argues that addressing both of these global threats locally, using nature-based solutions in urban areas, can and should be a top priority in urban-sustainability agendas. Given the projected trajectories of these threats, urban leaders in both the public and private sectors should urgently pursue unified, nature-based responses that simultaneously *restore regional ecosystems* and *prevent and treat chronic diseases. But for nature-based solutions to achieve both goals in any given location, and to create the magnitude of impact necessary to successfully reverse current trajectories, there are specific designs, features, and operational requirements (collectively, the "special sauce") that need to be incorporated at the site and regional scales when implementing these unified solutions. Furthermore, we must recognize that the private sector is an*

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indispensable partner if cities are to build and expand these powerful, unified solutions at scale, and implementation teams will require the right mix of stakeholders, as well as reasonable financial returns, to achieve broad-spectrum success. This Article proposes a vision of a specific nature-based solution — "Health Forests" — that incorporates the special sauce and the right mix of stakeholders. Using findings from literature reviews and interviews with practitioners in the healthcare industry, this article explains (i) the need to locate Health Forests on urban lands nested within residential, commercial, and mixed-use neighborhoods, (ii) the key factors that quickly optimize Health Forests for maximum benefit, (iii) the critical importance of expanding the land area allocated for Health Forests, and the resulting need to use private as well as public lands for them, and (iv) the types of investments, financial returns, and stakeholder partnerships that will enable the private sector to participate in creating, owning, operating, and funding financially sustainable Health Forests. This vision allows for replicability so that Health Forests can be expanded into connected regional networks, all while creating outsized benefits for overburdened and underserved neighborhoods. This Article closes with examples of legal structures that could be put in place to allow key stakeholders to partner for maximum environmental, health, and financial benefits.

INTRODUCTION

While urban sustainability discourse often centers on decarbonizing our energy sources,[1] reducing waste,[2] creating a circular economy,[3] and promoting "compact" development,[4] too often the conversation overlooks the essential role cities must play in physically restoring and regenerating the natural ecosystems that support our daily existence. As urban sustainability practitioners, our conversation must address both how we will continue to

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1. A top priority on urban sustainability and climate change agendas is removing fossil fuels from energy sources that power the urban built environment. *See, e.g.*, *About Us*, INST. FOR MKT. TRANSFORMATION, https://www.imt.org/about/ [https://perma.cc/WN5K-3PH8] (focused on reducing pollution, protecting health, creating wealth and economic opportunity, and enabling resilient communities through energy efficiency and removal of fossil fuels from building energy sources); *Why Buildings?*, INST. FOR MKT. TRANSFORMATION, https://www.imt.org/why-buildings/ [https://perma.cc/EK9T-JLEF] ("IMT is on a mission to equitably decarbonize buildings in this decade and improve the livability of our communities."); *Our Work*, WORLD RES. INST. ROSS CTR. FOR SUSTAINABLE CITES, https://www.wri.org/cities/our-work [https://perma.cc/46KH-2X7B] (last visited July 21, 2023) (focusing on sustainable and safe urban transport, mobility, and design; and urban efficiency and climate, consisting of helping cities optimize, electrify and decarbonize).

2. *See Managing and Reducing Wastes: A Guide for Commercial Buildings*, ENVT'L PROT. AGENCY, https://www.epa.gov/smm/managing-and-reducing-wastes-guide-commercial-buildings [https://perma.cc/ZW6K-36HJ] (last visited Sept. 10, 2023); *How Communities Have Defined Zero Waste*, ENVT'L PROT. AGENCY, https://www.epa.gov/transforming-waste-tool/how-communities-have-defined-zero-waste [https://perma.cc/G4GE-RKY6] (last visited Sept. 10, 2023); *see also How Can We Reduce Plastic Pollution?*, CALTECH SCI. EXCH. https://scienceexchange.caltech.edu/topics/sustainability/plastic-waste-pollution [https://perma.cc/E4QJ-NEAG] (last visited Sept. 10, 2023) (especially from products largely consumed by urban populations); *International Day of Zero Waste*, U.N., https://www.un.org/en/observances/zero-waste-day [https://perma.cc/EP3N-2UPP] (last visited Sept. 10, 2023).

3. *See* Erin Simon, *An Ambitious Global Treaty Is a Crucial Step in Solving the Plastic Crisis*, GREENBIZ (Jan. 19, 2023), https://www.greenbiz.com/article/ambitious-global-treaty-crucial-step-solving-plastic-crisis [https://perma.cc/3XKM-BW7C] (defining a circular economy as "an economy in which products can retain their value at every stage of their life cycle, from the moment we first extract the raw materials to product design, fabrication, use, reuse, recover and ultimately recycle"). The call for "circularity" is bolder than merely reducing waste, and ties closely into a vision of zero-waste (in which all "waste" products are reincorporated into other products or uses). *See How Communities Have Defined Zero Waste*, *supra* note 2; *Cities and the Circular Economy*, ELLEN MACARTHUR FOUND., https://ellenmacarthurfoundation.org/cities-and-the-circular-economy-deep-dive [https://perma.cc/8VGJ-AAD2] (last visited Sept. 10, 2023) ("Imagine the possibilities if buildings were designed like Lego. Easily assembled and disassembled, their different components or materials could be recovered and reused rather than being landfilled.").

4. *See About Smart Growth*, ENVT'L PROT. AGENCY (July 19, 2016), https://www.epa.gov/smartgrowth [https://perma.cc/WX39-752T] (The U.S. government advocates for urban smart growth as part of its sustainable-cities agenda. "Development guided by smart growth principles can minimize air and water pollution, reduce greenhouse gas emissions, encourage cleanup and reuse of contaminated properties, and preserve natural lands.").

get what we need from ever-strained ecosystems[5] and what these ecosystems need from us, especially as human population and climate change pressures intensify around the globe. When we drill down into those questions, we are forced to confront and question long-held beliefs about urban land use, form, and growth, and rethink the role of nature in cities. At the same time, though often raised as a distinct concern, voices within the healthcare community have been sounding the alarm on the rise of chronic diseases[6] and the ways that modern urban lifestyles and enculturated habits[7] are accelerating that

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5. *See* Will Steffen et al., *Planetary Boundaries: Guiding Human Development on a Changing Planet*, 347 SCI. 6223 (Feb. 13, 2015), https://doi.org/10.1126/science.1259855 [https://perma.cc/CTD6-5KJY]; *see also* Will Steffen et al., *Trajectories of the Earth System in the Anthropocene*, PROC. NAT'L ACAD. SCI. USA 115, 8252–59 (Aug. 4, 2018); MATT LEE-ASHLEY ET AL., HOW MUCH NATURE SHOULD AMERICA KEEP?, CTR. AM. PROGRESS, at 6 (Aug. 16, 2019), https://www.americanprogress.org/wp-content/uploads/sites/2/2019/08/NatureAmerica-report.pdf [https://perma.cc/LU64-VSGQ] ("The 2015 Paris Agreement, a landmark international plan to limit global temperature increases, is, according to a 2019 study in Science Advances, "only a half-deal; it will not alone save the diversity of life on Earth or conserve ecosystem services upon which humanity depends. It is also reliant on natural climate solutions that require bolstering outside of the Paris Agreement to ensure that these natural approaches can contribute to its success." (citing Eric Dinerstein et al., *A Global Deal for Nature: Guiding Principles, Milestones, and Targets*, 5 SCI. ADVANCES 1 (2019))).

6. *See About Chronic Diseases*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/chronicdisease/about/index.htm [https://perma.cc/QM8M-EE4L] ("Chronic diseases are defined broadly as conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both. Chronic diseases such as heart disease, cancer, and diabetes are the leading causes of death and disability in the United States."). This Article uses the term "chronic disease" primarily to refer to cardiovascular disease (CVD), hypertension, Type 2 diabetes mellitus, allergies/auto-immune dysregulation, and cognitive or mental health conditions like attention deficit disorder, depression, and anxiety.

7. Many chronic diseases, and particularly those highlighted in this Article, are caused in large part by lifestyle choices, cultural habits, and daily stressors common in American cities today. These include a short list of risk behaviors, such as poor nutrition/diet, lack of physical activity, and tobacco and alcohol use. *See About Chronic Diseases*, *supra* note 6; *Public Health and Chronic Disease: Cost Savings and Return on Investment*, AM. PUB. HEALTH ASS'N, https://www.apha.org/~/media/files/pdf/factsheets/chronicdiseasefact_final.ashx [https://perma.cc/9L7Y-H2AU]. Quite commonly, urban lifestyles in the United States are characterized by sedentary work habits, extended exposures to computer screens, excessive time indoors during daylight hours, poor nutrition, and exposure to chronic stressors from intense workloads, low incomes, inadequate housing, etc. *See Evidence Behind The Movement Concept*, WELL BLDG. INST. (2021), https://f.hubspotusercontent40.net/hubfs/7039796/Evidence%20Box/Movement%20Concept%20Research%20Digest.pdf [https://perma.cc/JJ9Z-PJD9] ("Physical inactivity is a prominent global public health challenge. Globally, about 25% of adults and 80% of children do not achieve the recommended levels of physical activity."); *Prevalence of Insufficient Physical Activity Among Adults Aged 18+ Years*, WHO, https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-insufficient-physical-activity-among-adults-aged-18-years-(age-standardized-estimate)-(-) [https://perma.cc/Q3PM-GCK5] (last visited Sept. 10, 2023) (showing risk factors in United

trend. These diseases are costly for individuals, employers, healthcare payers,[8] and society at large.[9] Yet, urban lifestyles and enculturated habits are not simply choices people make in a vacuum: they are powerfully influenced by urban land use, form, and growth patterns,[10] many of which

States). Enculturated habits may include frequent exposure to video or computer screens and mobility choices (e.g., motorized transportation over human-powered transport), which can also promote disease. *See generally* Lawrence D. Frank & Peter O. Engelke, *The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health*, 16 OHIO STATE UNIV. 202 (2001); Chloe Reichel, *The Health Effects of Screen Time on Children: A Research Roundup*, HARV. KENNEDY SCH. SHORENSTEIN CTR. ON MEDIA, POLS. & PUB. POL'Y (May 14, 2019), https://journalistsresource.org/education/screen-time-children-health-research/ [https://perma.cc/8BQ8-NTN3]; *see also* Gregory N. Bratman et al., *Nature and Mental Health: An Ecosystem Service Perspective*, 5 SCI. ADVANCES 1, 3 (2019) ("In many instances, modern living habits involve reduced regular contact with outdoor nature and increased time spent indoors, on screens, and performing sedentary activities."). Chronic diseases are also exacerbated by environmental pollution, exposure to toxins, and exposure to chronic stressors like intense work demands, long work hours, or inadequate housing. *See* Jennifer R. Wolch et al., *Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'*, 125 LANDSCAPE & URB. PLANNING 234, 235 (2014); Jared M. Ulmer et al., *Multiple Health Benefits of Urban Tree Canopy: The Mounting Evidence for a Green Prescription*, 42 HEALTH & PLACE 54, 54 (2016) ("Urbanization is often associated with social stress, physical threats (e.g., crime, traffic safety), and adverse environmental exposures (e.g., noise, air pollution). Contemporary lifestyles are generally associated with large reductions in occupational, domestic, and transportation-related physical activity, offset by only a small increase in leisure activity. In combination with changes in dietary intake, these trends have led to the high current rate of obesity and associated health risks, quality of life reduction, and health care cost increases." (internal citations omitted)); *see generally* Rebekah Levine Coley et al., *Where Does Community Grow?: The Social Context Created by Nature in Urban Public Housing*, 29 ENV'T & BEHAV. 468 (1997); Jean C. Bikomeye et al., *The Impact of Greenspace or Nature-Based Interventions on Cardiovascular Health or Cancer-Related Outcomes: A Systemic Review of Experimental Studies*, 17 PLOS ONE e0276517, e0276519 (2022) ("Neighborhood social and built environments, including nature and greenspaces, are key determinants of health and important factors in predicting health outcomes, including for CVD and cancer. Recent estimates suggest that 70%-80% of CVD burden might be attributable to non-genetic environmental factors, such as lifestyle choices, socioeconomic status (SES), air pollution, lack of neighborhood greenness, and poorer residential characteristics.").

8. For purposes of this Article, "healthcare payer" is defined as the third-party private company (e.g., health insurance company, self-insured employer) that pays all or a portion of the healthcare costs of medical care for a patient (in addition to whatever amount the patient pays out-of-pocket).

9. Social costs of chronic disease can be both direct and indirect, and they not only increase mortality rates, but also the frequency and type of treatments costs introduced over years before death. *See infra* Section I.A (Magnitude of the Problem).

10. Although urbanization creates a wide range of positive and negative effects on human health, some urban forms/design do better than others at promoting human health on a range of indicators. *See* Todd Litman, *Urban Sanity: Understanding Urban Mental Health Impacts and How to Create Saner, Happier Cities*, VICTORIA TRANSP. POL'Y INST. (June 30, 2023), https://www.vtpi.org/urban-sanity.pdf [https://perma.cc/9X3A-8Z3W]; *see also What are the Benefits of Nature in Cities and Towns?*, GREEN CITIES GOOD HEALTH, U. WASH., https://depts.washington.edu/hhwb/Top_Introduction.html [https://perma.cc/374X-J5HS] (last visited July 28, 2023). Often, urban lifestyles, land uses, and city configurations are a

have been shaped by blatant disregard for environmental systems and by legacies of racism and institutionalized segregation.[11]

If our urban sustainability conversations render visible the central and fundamental role that urban Nature[12] plays in every city's ability to address

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major cause (or contributing factor to) the national rise in chronic diseases in cities. *See* Danielle F. Shanahan et al., *Health Benefits from Nature Experiences Depend on Dose*, 6 SCI. REPS. (2016). Urban sprawl, in particular, has been associated with reduced physical health. *See* Peter Congdon, *Obesity and Urb. Env'ts*, INT'L J. ENVT'L RSCH. & PUB. HEALTH (Feb. 5, 2019), https://pubmed.ncbi.nlm.nih.gov/30764541/ [https://perma.cc/5699-WHRJ]; *see also* Frank & Engelke, *supra* note 7; *Chronic Conditions Lead Health Care Spend in the U.S.*, UNITEDHEALTHCARE (Apr. 26, 2023), https://www.uhc.com/employer/news-strategies/resources/chronic-conditions-lead-health-care-spend-in-the-us [https://perma.cc/96JV-Z827].

11. *See* Shivani Shukla, *Racial Disparities in Access to Public Green Space*, CHI. POL'Y REV. (2020), https://chicagopolicyreview.org/2020/09/23/racial-disparity-in-access-to-public-green-space/ [https://perma.cc/6D7G-C83B]; Jean C. Bikomeye et al., *Resilience and Equity in a Time of Crises: Investing in Public Urban Greenspace is Now More Essential than Ever in the US and Beyond*, 18 INT'L J. ENVT'L RSCH. & PUB. HEALTH 8420, 8423 (2021); Jeremy Hinsdale, *Study Maps Urban Heat Islands With Focus on Environmental Justice*, COLUM. CLIMATE SCH.: CLIMATE, EARTH, AND SOC'Y (Aug. 26, 2021), https://news.climate.columbia.edu/2021/08/26/study-maps-urban-heat-islands-with-focus-on-environmental-justice/ [https://perma.cc/WFA5-HVDE]; *Environmental Justice*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/whats-at-risk/environmental-justice [https://perma.cc/AX4T-LTEG] (last visited July 21, 2023); *see also* LEE-ASHLEY ET AL., *supra* note 5, at 10 ("Legacies of racism, exclusion, and injustice affect nearly all aspects of natural resource policy—from land development patterns and the demographic composition of regulatory agencies to the vulnerabilities of communities to fires, floods, and other natural disasters."). *See generally* RICHARD ROTHSTEIN, THE COLOR OF LAW: A FORGOTTEN HISTORY OF HOW OUR GOVERNMENT SEGREGATED AMERICA (2017). Ironically, these legacies not only negatively affect the most overburdened and underserved communities (including low-to-moderate income communities and communities of color) but also those who have ostensibly "benefited" from these legacies — particularly with respect to those who live in automobile-dependent suburban neighborhoods with long commute times to work centers (and who now suffer from heavy reliance on technology, car travel, time indoors, social isolation, and high costs of living). *See* Shima Hamidi et al., *Associations between Urban Sprawl & Life Expectancy in the U.S.*, INT'L J. ENVT'L RSCH. & PUB. HEALTH (2018), https://www.mdpi.com/1660-4601/15/5/861 [https://perma.cc/FB3K-B338]; Yan Yan et al., *How Does Urban Sprawl Affect Pub. Health? Evidence from Panel Survey Data in Urbanizing China*, INT'L J. ENVT'L RSCH. & PUB. HEALTH (2021), https://www.mdpi.com/journal/ijerph [https://perma.cc/UT3X-DE5B].

12. The term "nature" carries a broad array of meanings in both academic and lay literature. *See* Terry Hartig et al., *Nature and Health*, 35 ANN. REV. PUB. HEALTH 207, 208 (2014). This Article uses the capitalized term "Nature" to denote natural ecosystems, or ecosystem fragments, that are native to a particular location. Bratman et al. use the concept similarly: "Nature encompasses elements and phenomena of Earth's lands, waters, and biodiversity, across spatial scales and degrees of human influence, from a potted plant or a small urban creek or park to expansive, 'pristine' wilderness with its dynamics of fire, weather, geology, and other forces." Bratman et al., *supra* note 7, at 105; Hartig et al. at 2. In this Article, reference to urban "Nature" should be distinguished from "Urban Greenspace" which is often not the same as, or even close to, a replica of native ecosystems. "Urban Greenspace" often refers to a "continuum from intact remnant patches of native vegetation, brownfields, gardens, and yards, to essentially terraformed patches of vegetation that may or

these two sets of emerging threats (i.e., global and regional/local ecosystem breakdowns, and the rise in chronic diseases), we can create new solutions that accelerate positive outcomes. Nature in the urban space,[13] including green infrastructure,[14] local ecosystems, native habitat, and Nature-Based Solutions,[15] can guide us to a unified response to these threats, which are

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may not be representative of native community associations." Myla F.J. Aronson et al., *Biodiversity in the City: Key Challenges for Urban Green Space Management*, 15 FRONTIERS IN ECOLOGY & ENV'T 189, 189–96 (2017). Haaland et al. define Urban Greenspace broadly as "any vegetation found in the urban environment, including parks, open spaces, residential gardens, or street trees." Christine Haaland & Cecil Konijnendijk van den Bosch, *Challenges and Strategies for Urban Green-Space Planning in Cities Undergoing Densification: A Review*, 14 URB. FORESTRY & URB. GREENING 760, 761 (2015) (internal citations omitted). Many studies show positive effects on human health from most types of Urban Greenspace, but here I use the term "Nature" more narrowly. I do, however, include concepts of green infrastructure as defined in Note 14 and Nature-Based Solutions as defined in Note 15 within my use of the term. *See infra* notes 14–15.

13. *See generally* Kathleen F. Wolf et al., *Urban Trees and Human Health: A Scoping Review*, 17 INT'L J. ENV'T RSCH. & PUB. HEALTH 4371 (2020); Kathleen F. Wolf et al., *Urban Green Spaces: A Brief for Action*, WORLD HEALTH ORG. (2017), https://apps.who.int/iris/handle/10665/344116 [https://perma.cc/A6QZ-VBQS]; Ulmer et al., *supra* note 7.

14. The term "green infrastructure" has been construed both broadly and narrowly in different contexts. The U.S. EPA uses the term narrowly to refer to nature-based solutions used for stormwater management and urban stormwater runoff. *See What is Green Infrastructure?*, ENVT'L PROT. AGENCY, https://www.epa.gov/green-infrastructure/what-green-infrastructure [https://perma.cc/832W-JS9R] (last visited July 21, 2023). The term has also been defined as "natural areas and open spaces that provide multiple benefits for people and wildlife, such as parks and nature preserves, river corridors and greenways, and wetlands. In developed areas, green infrastructure includes resources and practices such as the urban forest, green streets, green roofs, rain gardens, and pervious pavement." David Morley & Anna Read, *Supporting Regional Green Infrastructure Network Through Loc. Policy and Action*, AM. PLAN. ASS'N (Jan. 2016), https://www.vibrantcitieslab.com/wordpress/wp-content/uploads/2017/05/Supporting-a-Regional-GI-Plan-Through-Local-Policy.pdf [https://perma.cc/XS4D-LCNC]. This Article generally adopts the APA definition of green infrastructure but, with respect to practices in developed areas, it does so only to the extent the definition refers to practices that use vegetation native to the particular location.

15. The term "Nature-Based Solution" can mean a broad array of physical installations and landscapes that incorporate natural features, vegetation, and processes to perform certain actions: "Nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits." *See* WHITE HOUSE COUNCIL ON ENVT'L QUALITY, WHITE HOUSE OFFICE OF SCI. & TECH. POL'Y, WHITE HOUSE DOMESTIC CLIMATE POL'Y OFF., OPPORTUNITIES FOR ACCELERATING NATURE-BASED SOLUTIONS: A ROADMAP FOR CLIMATE PROGRESS, THRIVING NATURE, EQUITY, AND PROSPERITY 38 (2022) [hereinafter WHITE HOUSE REP.]. Cohen-Shacham et al. classify "Nature-based Solutions (NbS) approaches as: (i) ecosystem restoration approaches (e.g. ecological restoration, ecological engineering and forest landscape restoration); (ii) issue specific ecosystem-related approaches (e.g. ecosystem-based adaptation, ecosystem-based mitigation, and ecosystem-based disaster risk reduction); (iii) infrastructure-related approaches (e.g. natural infrastructure and green infrastructure approaches); (iv) ecosystem-based management approaches (e.g. integrated coastal zone

some of the worst environmental and health problems facing U.S. cities today. This Article explores emerging research that is revealing deeply underappreciated[16] but powerful nature-based approaches to reducing chronic disease: namely, immersing people in certain kinds of Nature spaces ("NT/NBS"[17]), often incorporating nature-based health practices ("NT/NBS Health Programming"), in order to create mental and physical experiences that produce wide-ranging health benefits at low cost.[18] Based on my own

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management and integrated water resources management); and (v) ecosystem protection approaches (e.g. area-based conservation approaches including protected area management)." EMMANUELLE COHEN-SHACHAM ET AL., NATURE-BASED SOLUTIONS TO ADDRESS GLOBAL SOCIETAL CHALLENGES xii (2016), https://portals.iucn.org/library/node/46191 [https://perma.cc/896W-9MSN]. In this Article, I limit the term "Nature-Based Solutions" to refer to installations and landscapes that incorporate or mimic ecosystem habitats native to the given location.

16. The failure to appreciate nature-health connections is caused by numerous institutional barriers at every scale. One key barrier, however, is caused by extensive challenges in both measuring and contracting for improvements in social determinants of health, which would include nature-based health interventions, particularly with regard to measuring effectiveness and impact. *See* Kelsey Waddill, *The State of Payer, CBO Social Determinants of Health Contracting*, HEALTHPAYER INTEL. (Sept. 22, 2021), https://healthpayerintelligence.com/news/the-state-of-ma-cbo-social-determinants-of-health-contracting [https://perma.cc/S6TQ-MJB5]. It is also the case that Nature-Based Solutions writ large have, until recently, been underappreciated in the fight against climate change, which compounds the underemphasis on working with Nature to achieve solutions to social and environmental problems. *See* Fred Pearce, *Why Are Nature-Based Solutions on Climate Being Overlooked?*, YALE ENV'T 360 (Apr. 18, 2022), https://e360.yale.edu/features/why-are-nature-based-solutions-on-climate-being-overlooked [https://perma.cc/J6HL-AGDN]; *see generally* WHITE HOUSE REP., *supra* note 15 (detailing national-scale funding gaps and historic lack of public assistance).

17. This acronym is generated from combining "nature therapy" and "nature-based solutions," and it is shorthand for a set of nature-based health practices that intentionally incorporate features of natural ecosystems into health-focused experiences and treatments. Although some nature-based health practices use intensely designed/engineered gardens and greenspaces, those that use Nature, are referred to here as "NT/NBS." *See supra* note 12 (definition of Nature). NT/NBS can incorporate a wide variety of health-based programming into nature experiences.

18. "Nature-based health practices" refers to a broad collection of activities in which humans experience connections to nature for therapeutic purposes. These are forms of planned or intentional human-nature experiences that connect body and mind to aspects of Nature for promoting health. Examples include Forest Bathing, Shinrin Yoku, Horticultural Rehabilitation, outdoor schools or educational programming designed to prevent or address cognitive-behavioral problems, wilderness experiences (including hiking, camping, rock-climbing, biking), and visits to local parks. Occasionally, people refer to these practices as "nature therapy"; however, there is no consensus as to the parameters of this term. There are attempts to build consensus around what constitutes "nature therapy" and whether a healthcare provider is appropriately trained to provide such care. *See Home*, ASS'N NATURE FOREST & THERAPY, https://www.natureandforesttherapy.earth [https://perma.cc/J54E-QGNF] (last visited July 29, 2023); *Research & Practice of Forest Therapy for Public Health*, INT'L NATURE & FOREST THERAPY ALL, https://infta.net/ [https://perma.cc/2TCX-N3UA] (last visited July 22, 2023).

research conducted between 2020-2022,[19] in combination with literature reviews, this Article incorporates key findings about NT/NBS into a vision and roadmap for creating what I call "Health Forests:"[20] optimized and financially sustainable urban NT/NBS that are owned and operated by private partnerships of key stakeholders for the equal benefit of natural ecosystems and population health.

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19. In this Article, I include findings from research I conducted between fall 2020 and spring 2022 as part of my masters project in the Duke Environmental Leadership and Master of Environmental Management (DEL-MEM) program at Duke University. *See generally* Rachel Toker, Health Forests: Scaling Up Urban Forests as a Health Response (2022) (M.E.M. thesis, Duke University), https://dukespace.lib.duke.edu/dspace/handle/10161/24861 [https://perma.cc/KF4D-LM2C] [hereinafter Toker Thesis]. Through literature reviews and personal interviews with nature-based healthcare providers, and medical, public health, nursing, academic, and landscape design professionals conducted between spring 2021 and spring 2022, I explored the best ways to design, locate, and conduct NT/NBS so that they prioritize and maximize health and ecological restoration outcomes equally. *See generally* Toker Thesis. I note that the research used for this Article was produced within the principles, rules, and confines of a body of scientific research approved or funded by governments, academic institutions, and associations of scientists that have been shaped by the Western World. There is an entire body of indigenous knowledge, much of which is not approved, funded, or published under those auspices, that has recognized these health-nature connections for thousands of years but that could not be incorporated here due to time, space, and scoping restraints. The Author recognizes the importance of this indigenous knowledge and notes its absence as a limitation of this work. *See e.g.*, Alice Bell et al., *Indigenous Leadership is the Key to Unlocking Value in Nature-Based Solutions*, WORLD ECON. F. (Jan. 11, 2023), https://www.weforum.org/agenda/2023/01/davos23-nature-based-solutions-without-indigenous-leadership-fail-investors-and-the-planet/ [https://perma.cc/X6UQ-45XZ]; Brennan Vogel et al., *Indigenous-Led Nature-Based Solutions for the Climate Crisis: Insights from Canada*, MDPI (May 31, 2022), https://www.mdpi.com/2071-1050/14/11/6725 [https://perma.cc/GF8P-CFDU]; Enrique Salmón, *Kincentric Ecology: Indigenous Perceptions of the Human-Nature Relationship*, 10 ECOLOGICAL APPLICATIONS 1327, 1327–32 (2000).

20. See *infra* Section II.C for a full description of Health Forests and how they should work. My focus on forests is due in part to the fact that my research focused on piedmont areas of the eastern portion of the United States, generally defined by EPA as Level II EcoRegion 8/8.3 (Temperate eastern forest). Health Forests are optimal for piedmont ecoregions due to the soils, predevelopment native habitat, and moisture levels of those ecoregions. *See Piedmont Ecoregion*, LANDSCOPE AM., http://www.landscope.org/explore/natural_geographies/ecoregions/Piedmont/ [https://perma.cc/CD7L-Q9LQ] (last visited July 22, 2023). Financial modeling focuses on mid-Atlantic as generally representative of piedmont regions in the Chesapeake Bay Watershed. However, my research interviews suggest that Health Forest concepts could fit Level II EcoRegion 6.2 in the upper northwestern section of the U.S. with similar ease. *See* Toker Thesis, *supra* note 19, at 19–23. Non-forest NT/NBS (based on native habitat from other eco-regions – like meadow/prairie) almost certainly offer many of the same health benefits, given the research finding positive health outcomes from a broad array of Urban Greenspaces; however, I did not focus on ways to optimize health/environmental features in those contexts or examine the most cost-effective ways to achieve optimized and financially sustainable outcomes in those contexts.

This Article reviews why we should — and what is needed to — implement Health Forests as a unified urban response to ecological degradation and rising chronic disease. Part I summarizes the expanding research demonstrating (i) the importance of using urban space for ecological restoration and (ii) the wide-ranging benefits of NT/NBS in the treatment and prevention of chronic disease. Part II articulates essential characteristics of NT/NBS that maximize both ecological and health benefits and then defines the parameters and requirements of Health Forests that are necessary to maximize these benefits in cities in the most cost-efficient ways. Part III examines the "micro-economy" that can be established through new collaborations of healthcare payers, health program providers (HPPs),[21] urban foresters and ecological restoration companies, socially vulnerable communities,[22] and real estate developers — all stakeholders who are essential for successfully implementing these creative solutions. Part III also considers how private investors could fund networks of Health Forests, looking at the financial feasibility of, and potential financial returns from, implementing Health Forests and the scale of required investments. Part IV then explores the kinds of innovative collaborations that could enable the necessary parties to fund, operate, and maintain Health Forests for maximum benefit at scale. Part IV also describes two hypothetical and scalable legal structures for implementation that could achieve key objectives and unlock numerous benefits in the process.

Using Health Forests in cities — especially if they are located within connected networks or matrices of forests — can heal regional ecosystems, improve urban adaptation to the effects of climate change, and reverse the trend of rising chronic diseases, all while having outsized benefits for overburdened and historically underserved/socially vulnerable communities.[23] Yet, there are at least three core reasons why people have

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21. Health program providers are the doctors, therapists, and group leaders trained in nature-based health practices who will deliver the NT/NBS Health Programming to insureds, intentionally incorporating Nature experience into patient treatment. HPPs should deliver services in coordination with the primary care physicians of the insureds (or treatment teams that may be in place for specific patients). Primary care physicians and other medical treatment teams should be trained to either deliver or understand the benefits of NT/NBS Health Programming and to work alongside health program providers. See *infra* Part IV for further discussion of the role of HPPs and how they could work in the context of Health Forests.

22. *See Climate Change and the Health of Socially Vulnerable People*, EPA (Dec. 13, 2022), https://www.epa.gov/climateimpacts/climate-change-and-health-socially-vulnerable-people [https://perma.cc/J3YM-5WAK] (definition of socially vulnerable people).

23. *See* LEE-ASHLEY ET AL., *supra* note 5, at 10 (Point #3: "Currently, the costs of nature's deterioration are falling disproportionately on economically disadvantaged communities and communities of color."); *see also* Bikomeye et al., *supra* note 11, at 8423; *supra* note 11 and accompanying text; *infra* note 27 and accompanying text.

not already started implementing urban NT/NBS as a unified response to ecosystem degradation and the rise of chronic disease: (i) cities have not yet prioritized, or believed in the efficacy of, urban Nature-Based Solutions to solve climate change or chronic disease problems,[24] in part because they do not know how to optimize them for maximum beneficial effects; (ii) the public sector cannot implement optimized urban NT/NBS at the necessary scale without private sector cooperation,[25] yet the private actors who could have sufficient profit motives to participate in and fund such efforts do not yet understand the financial opportunity they are missing; and (iii) the right mix of stakeholders have not yet assembled in the right kinds of ways to implement these solutions effectively.

To break through these barriers, we first need to understand *that* creating or restoring urban NT/NBS can help reverse regional ecosystem degradation and reduce chronic diseases with a unified response. Then, we need to look carefully at *how* we should locate, design, operate and manage NT/NBS to best achieve these multiple objectives comprehensively and efficiently, since there is a "special sauce" to making it work; and, finally, we need to examine *how* to assemble the teams of stakeholders[26] who are essential to successfully

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24. The failure of cities to prioritize urban NT/NBS as a solution is not uniform from city to city (or even urban neighborhood to urban neighborhood) — some cities embrace Nature-Based Solutions more than others. Lack of prioritization can be a result of competing political priorities that focus attention on entirely different social or economic needs, but it can also happen when city and industry leaders who are interested in Nature-Based Solutions face numerous barriers to understanding and implementing them, which is common. Some of these barriers are discussed in WHITE HOUSE REP., *supra* note 15, at 15. Another barrier is the lack of funding for robust scientific and medical research on these areas of cross-disciplinary academic study, which in turn inhibits the level of funding needed for program implementation. *Id.*

25. The public sector cannot expand Nature in cities without private sector cooperation, particularly in high-cost cities. For a discussion of the funding burden and benefits of Health Forests, and particularly land acquisition, see *infra* Part III. *See generally* Amanda J. Zellmer & Barbara S. Goto, *Urban Wildlife Corridors: Building Bridges for Wildlife and People*, 4 FRONTIERS IN SUSTAINABLE CITIES 1 (2022), https://www.frontiersin.org/articles/10.3389/frsc.2022.954089/full [https://perma.cc/2PCR-PSGD] (commentary on the substantial funding barriers to regenerating protected habitat on private lands in urban areas and the difficulties of attaining ecological goals across urban regions without using private land in urban areas); *see also* John Cleveland, Jon Croe, Lois DeBacker, Trine Munk & Peter Plastrik, *Hunting for Money: U.S. Cities Need a System for Financing Climate Resilience and Adaptation*, FED. RSRV. BANK S.F. (Oct. 17, 2019), https://www.frbsf.org/community-development/publications/community-development-investment-review/2019/october/hunting-for-money-u-s-cities-need-a-system-for-financing-climate-resilience-and-adaptation/[https://perma.cc/QJW2-G6SF].

26. Implementation teams will need to engage at least four key stakeholder constituencies that have not historically played an "agenda-setting" role in the comprehensive plans and spatial arrangement of U.S. cities: healthcare payer institutions (e.g., health insurance companies, self-ensured employers), healthcare providers — particularly HPPs (defined above), urban forest and ecological restoration experts, and at-risk or socially vulnerable urban neighborhoods. For evidence showing a historic lack of input from these stakeholder

fund and implement these solutions. Implementing networks of Health Forests will require new ways of thinking about urban space *and* innovative partnerships, which can create new economic markets in the process. This Article articulates the steps to overcome the barriers described above. In the process, Nature can help us achieve climate resilience, climate equity, and chronic disease prevention and treatment (particularly among poor and overburdened communities)[27] more effectively than we do today.

I. TWO LOOMING URBAN CRISES AND PARTNERING WITH NATURE FOR SOLUTIONS

Urban communities face two substantial environmental and health problems of growing magnitude: (i) increasing global, regional, and local ecosystem degradation,[28] and (ii) a rise in the prevalence of chronic diseases.[29] Both are either caused or exacerbated by the loss of Nature in expanding cities. Restoring regional ecosystems and reversing declines in public health (and related increases in healthcare spending) are both essential for urban populations — and the national economy — to survive and thrive.[30] Meanwhile, though these crises were once relatively independent

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groups, see generally Shorna Allred, Richard Stedman, Laura Heady & Karen Strong, *Incorporating Biodiversity in Municipal Land-Use Planning: An Assessment of Technical Assistance, Policy Capacity, and Conservation Outcomes in New York's Hudson Valley*, 104 LAND USE POL'Y 105344 (2021); *see also Planning History Timeline*, AM. PLAN. ASS'N, https://www.planning.org/timeline [https://perma.cc/4BTY-L3SP] (last visited July 29, 2023); Track2Training, *The History of Urban Planning*, INT'L J. RSCH. (Apr. 30, 2022, 10:29 PM), https://internationaljournalofresearch.com/2021/04/30/the-history-of-urban-planning%E2%80%AF/ [https://perma.cc/9JX3-X9E4].

27. Poor and overburdened communities are often the most vulnerable and most exposed to climate threats that can be addressed with Nature-Based Solutions. *See supra* notes 11, 23; *Climate Change*, CHESAPEAKE BAY FOUND., https://www.cbf.org/issues/climate-change/ [https://perma.cc/2SYQ-3B9Q] (last visited July 29, 2023) ("Rising temperatures on land may be one of the deadliest impacts of climate change. Cities are disproportionately affected. They are often warmer than surrounding rural areas due to the high density of roads, buildings, and hard surfaces, a phenomenon called the urban heat island effect. Even within the same city, certain neighborhoods are hotter—as much as 16 degrees Fahrenheit hotter, according to a 2019 study that looked at heat variations in Richmond, Baltimore, and Washington, D.C. One of the study's researchers, Jeremy Hoffman, Chief Scientist at the Science Museum of Virginia, found the hottest neighborhoods today are the same neighborhoods once redlined under racially discriminatory home lending practices in the mid-1900s. These neighborhoods often remain lower income and communities of color, with fewer trees and open spaces, exposing residents who need to walk or use public transportation to dangerous heat."); Kirsten Schwarz et al., *Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice*, PLOS ONE (Apr. 1, 2015), https://doi.org/10.1371/journal.pone.0122051 [https://perma.cc/52QT-42BA].

28. See *infra*, Section I.A, notes 33–61 and accompanying text.

29. *See infra*, Section I.A, notes 62–73 and accompanying text.

30. *See infra* notes 59–73 and accompanying text; *see also Chronic Disease Rates and Management Strain the U.S. Healthcare System*, TECHTARGET (Sept. 6, 2022),

of one another, now they are interlinked,[31] often leaving socially vulnerable people and people with chronic disease at greatest risk.[32] The disturbing trends in both sets of problems, described in more detail below, can be addressed at the city scale by expanding urban Nature with Health Forests, as defined in Part II of this Article.

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https://lifesciencesintelligence.com/features/chronic-disease-rates-and-management-strain-the-us-healthcare-system [https://perma.cc/WZL2-SBEZ] ("The rates of chronic disease in the US and the resources required to manage them strains the healthcare system in multiple ways."); Hugh Waters & Marlon Graf, *The Cost of Chronic Disease in the U.S.*, MILKEN INST. (Aug. 28, 2018), https://milkeninstitute.org/report/costs-chronic-disease-us; [https://perma.cc/6CYH-ZEBM]; *Climate Change and the Health of People with Chronic Medical Conditions*, ENVT'L PROT. AGENCY (Dec. 13, 2022), https://www.epa.gov/climateimpacts/climate-change-and-health-people-chronic-medical-conditions [https://perma.cc/XU6B-Q27U]; Dinerstein, et al., *supra* note 5, at 1 ("Natural ecosystems are key to maintaining human prosperity in a warming world.").

31. *See infra* Section I.A, notes 36–47 and accompanying text. Today, there are numerous negative interactions among public health threats and the consequences of ecosystem degradation in urban regions. A full examination of these relationships is beyond the scope of this article, but examples include the ways that intense heat from climate change can exacerbate chronic diseases like cardiovascular disease and how expanding urban populations cause more intense heat island effects by destroying more and more local urban Nature. *See* Science Communication Unit, *Future Brief 24: The Solution is in Nature*, SCI. FOR ENVT'L POL'Y 3, 5 (2021) ("All areas of the world, urban and non-urban alike, are facing interlinked and interdependent climate, biodiversity, overexploitation and health crises."); Harikrishna Halaharvi et al., *Heat Exposure and Cardiovascular Health: A Summary for Health Departments*, CTRS. FOR DISEASE CTRL. & PREVENTION, at 3 (2020).

32. One well-documented example of how these challenges are now interacting occurs during intense heat waves caused by climate change. *See* Rachel Nania, *Heat Waves Can be Hard on the Heart*, AM. ASS'N RET. PERSONS (July 24, 2023), https://www.aarp.org/health/conditions-treatments/info-2023/extreme-heat-stroke-heart-attack-risk.html [https://perma.cc/8GQZ-4HWS]; *see also* Juanna Summers et al., *What Extreme Heat Means for Our Long Term Health*, NAT'L PUB. RADIO (July 21, 2022, 5:02 PM), https://www.npr.org/2022/07/21/1112777702/what-extreme-heat-means-for-our-long-term-health [https://perma.cc/SB53-KCHE]; Simon Lux et al., *IUCN Global Standard for Nature-Based Solutions*, INT'L UNION FOR CONSERVATION OF NATURE (2019), https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf; COMMUNITY HEAT MAPPING IN MONTGOMERY COUNTY 1, 3, https://storymaps.arcgis.com/stories/389babe7ce654fdd87701488ae72e8b6 [https://perma.cc/LMX8-XGKY] (last visited July 22, 2023) ("Extreme heat kills more Americans than any other weather event, but not everyone's risk is the same. Low-income communities and communities of color are disproportionately impacted by extreme heat." Additionally, "[h]eat exhaustion can directly lead to dehydration, heatstroke, and even heart issues. In areas where extreme heat is more common, long-term exposure can worsen chronic cardiovascular and respiratory illnesses. Extreme heat can also impact psychological well-being. Climate scientists find links between long-term heat exposure and mental health outcomes, such as aggression and chronic fatigue.").

A. The Magnitude of the Problems

1. Global and Local Ecosystem Degradation

Widespread degradation of global and local ecosystems is wreaking havoc on our world and way of life.[33] This degradation is producing two rapidly accelerating global environmental catastrophes — climate change and mass extinctions[34] — which, together with other negative consequences of such degradation, threaten the integrity of the Earth's biosphere and the longevity of human societies.[35] One of the major causes of ecosystem degradation is

33. *See* Will Steffen et al., *Trajectories of the Earth System in the Anthropocene*, 115 PROC. NAT'L ACAD. SCI. U.S. 8252, 8252–59 (2018); *see also* Ricardo Barra et al., *Making Peace with Nature*, U.N. ENV'T PROGRAMME, at 3 (2021), https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/34948/MPN.pdf [https://perma.cc/843U-KW66].

34. *See Finance for Nature-Based Solutions Must Triple by 2030*, U.N. CLIMATE CHANGE (Oct. 18, 2022), https://unfccc.int/news/finance-for-nature-based-solutions-must-triple-by-2030 [https://perma.cc/B4Q2-7UBF].

35. *See* Barra et al., *supra* note 33; *see also* Steffen et al., *supra* note 33, at 8252–59 ("Collective human action is required to steer the Earth System away from a potential threshold and stabilize it in a habitable interglacial-like state. Such action entails stewardship of the entire Earth System — biosphere, climate, and societies — and could include decarbonization of the global economy, enhancement of biosphere carbon sinks, behavioral changes, technological innovations, new governance arrangements, and transformed social values"); Dinerstein et al, *supra* note 5; Marie Quinney, *Fighting Climate Change Must Mean Preserving Nature*: *Guiding Principles, Milestones, and Targets*, GREENBIZ (June 30, 2021), https://www.greenbiz.com/article/fighting-climate-change-must-mean-preserving-nature [https://perma.cc/QS4X-JKSP] (Explaining the essential relationship between ability to fight climate change and loss of biodiversity: "While the integration of climate change and nature in policymaking and business strategy is not where it should be, the message is clear: the longevity of our societies and economies depends on it.").

urban development and expansion.[36] As cities grow across the world,[37] they displace and fragment natural areas, removing ecosystem functions from more and more lands.[38] This displacement can happen gradually, but unless policies are in place to avoid these results,[39] patterns of urban growth steadily degrade and destroy the surrounding local and regional ecosystems, chipping away at their ability to function until they can't anymore.[40] As smaller

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36. Although urban growth is not the sole reason for ecosystem degradation and the mass extinctions we are seeing globally, it meaningfully contributes to the process. Urbanization has been a major driver of habitat loss over recent decades. *See* Fernando Ascensao et al., *Nature in the Urban Century*, NATURE CONSERVANCY 1 (2018), https://www.nature.org/en-us/what-we-do/our-insights/perspectives/nature-in-the-urban-century/ [https://perma.cc/QTK4-MSVJ]; *see also Why Connectivity Matters to Wildlife — and People*, WORLD WILD LIFE FUND, https://www.worldwildlife.org/stories/why-connectivity-matters-to-wildlife-and-people [https://perma.cc/FA44-DJRN] (last visited July 22, 2023) (explaining loss of habitat from development of infrastructure and cities is a substantial factor in species extinctions and loss of habitat); Karen Seto et al., *Global Forecasts of Urban Expansion to 2030 and Direct Impacts on Biodiversity and Carbon Pools*, 109 PROC. NAT'L ACAD. SCI. U.S. 16083, 16084 (Sept. 17, 2012), https://www.pnas.org/doi/full/10.1073/pnas.1211658109 [https://perma.cc/EWW4-QV7V] ("Today, urban areas around the world are expanding on average twice as fast [as] their populations. . . . urban areas drive global environmental change. Urban expansion and associated land-cover change drives habitat loss, threatens biodiversity, and results in the loss of terrestrial carbon stored in vegetation biomass."); Erik Andersson et al., *Reconnecting Cities to the Biosphere: Stewardship of Green Infrastructure and Urban Ecosystem Services*, 43 KUNGL VETENSKAPS-AKADEMIEN 445, 445 (2014) ("Much of urban growth has been at the expense of the capacity of terrestrial and marine systems to generate and sustain essential ecosystem services . . . and is currently challenging biophysical planetary boundaries for the world as we know it . . . .").

37. U.N. DEP'T. OF ECON. & SOC. AFFS., *Around 2.5 Billion More People Will Be Living in Cities by 2050, Projects New UN Report*, U.N., https://www.un.org/en/desa/around-25-billion-more-people-will-be-living-cities-2050-projects-new-un-report [https://perma.cc/YKR6-7RQ5] (last visited July 30, 2023).

38. Ecosystem functions are the operations of healthy ecosystems. The term "ecosystem function" (and related term "ecologically functioning") can have a range of meanings, but it is used here to refer to the key functions of ecosystems that produce ecosystem services. *See generally* Puay Yok Tan et al., *A Conceptual Framework to Untangle the Concept of Urban Ecosystems*, 200 LANDSCAPE & URB. PLAN. 1 (2020). Ecosystem function depends in part on biodiversity and species richness, and it "depends on the identities, densities, biomasses, and interactions of populations of species within a community and the aggregate abundance and spatial and temporal variation of these attributes." *See* Dagmar Haase et al., *A Quantitative Review of Urban Ecosystem Service Assessments: Concepts, Models, and Implementation*, 43 KUNGL VETENSKAPS-AKADEMIEN 413, 414 (2014) (reviewing urban ecosystem functioning and ecosystem services). *See also generally* Haaland & Konijnendijk van den Bosch, *supra* note 12. See *infra* Section II.A for a discussion of specific drivers and indicators of ecosystem health.

39. Haaland describes studies that show infill development without planning for more public green space decreases not only greenspace but living standards in an entire neighborhood. *See* Haaland & Konijnendijk van den Bosch, *supra* note 12, at 763.

40. As one article put it: "Evaluating the condition of nature in the United States is a bit like watching a leaking pipe. If a person focuses on each drop as it falls to the floor, the leak hardly seems damaging. If they leave for the day, however, they are likely to come back to a

ecosystems degrade and lose ecosystem function, these losses weaken not only the local ecosystem, but national and global ecosystems as well. Loss of global biodiversity — an essential component of functioning ecosystems — has reached a fever pitch, due in part to habitat destruction for urban expansion and related infrastructure.[41] When natural ecosystems degrade and stop functioning, they also stop producing ecosystem services[42] that human societies need. Put simply, animals and plants create the conditions that are required for life on Earth:[43] they play a crucial part in providing ecosystem services, which are "all the benefits that we get from the proper function of nature for free . . . . These benefits span from the correct combination of gases in the atmosphere to potable water to nutrient

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room full of water." *See* LEE-ASHLEY ET AL., *supra* note 5, at 3 ("The scientific team at CSP found that human activities are causing the persistent and rapid loss of America's natural areas. The human footprint in the continental United States grew by more than 24 million acres from 2001 to 2017 — equivalent to the loss of roughly a football field worth of natural area every 30 seconds.").

41. *See* Barra et al., *supra* note 33, at 57. Some researchers claim that humans are causing the sixth mass extinction, both directly and indirectly, through habitat destruction, illegal trade and overexploitation of species, the spread of invasive species, pollution, emerging diseases and human-induced climate change. *See* Meara Isenberg, *Researchers Say We're in a Sixth Mass Extinction. This Time, Humans Are the Culprit*, CNET (May 28, 2022, 5:00 AM), https://www.cnet.com/science/features/researchers-say-were-in-the-sixth-mass-extinction-heres-why-it-matters/ [https://perma.cc/Z4JM-RB5W] (Ceballos warns this could have dire consequences for humans: "We're losing so many species that civilization is facing a possibility of global collapse in the next two or three decades.").

42. *See* Gulay Cetinkaya Ciftcioglu & Aslihan Aydin, *Urban Ecosystem Services Delivered by Green Open Spaces: An Example from Nicosia City in North Cyprus*, 190 ENVT'L MONIT. ASSESS. 1, 2 (Sept. 18, 2018) ("Ecosystem services are the benefits humans obtain from ecosystems. They are the processes, conditions, and subsets derived from ecosystems and ecological functions (e.g., primary productivity, carbon cycling, and decomposition), which sustain and enhance human wellbeing."); *see also* Martinez-Harms et al., *Making Decisions for Managing Ecosystem Services*, 184 BIOLOGICAL CONSERVATION 229 (Jan. 20, 2015); Haase et al., *supra* note 38; ERIK GÓMEZ-BAGGETHUN & ÅSA GREN, *Urban Ecosystem Services*, *in* URBANIZATION, BIODIVERSITY, AND ECOSYSTEM SERVS.: CHALLENGES & OPPORTUNITIES 175 (T. Elmqvist et al. eds., 2013) (discussing examples of ecosystem services, the relationship of urbanization to ecosystem decline, the relationship of ecosystem decline to loss of ecosystem services, and the potential for urban areas to reverse current manifestations of these relationships).

43. *See* Isenberg, *supra* note 41 ("Animals and plants create the conditions that are required for life on Earth. They play a crucial part in providing what scientists call ecosystem services, which are 'all the benefits that we get from the proper function of nature for free,' Ceballos said. These benefits span from the correct combination of gases in the atmosphere to potable water to nutrient cycling.").

cycling."[44] Urban land use and consumption choices globally are threatening the biosphere's very ability to function.[45]

While urban growth, in the aggregate, degrades *global* ecosystems,[46] individual urban expansions also degrade surrounding *regional and local* ecosystems.[47] In areas experiencing urban expansion and densification, these processes have been decreasing both the overall quantity of urban Nature and the ecological quality of the urban Nature that remains,[48]

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44. *Id.*; *see also* GÓMEZ-BAGGETHUN & GREN, *supra* note 42, at 176 (providing specific examples of a range of UES: "Provisioning services include all the material products obtained from ecosystems, including genetic resources, food and fiber, and fresh water. Regulating services include all the benefits obtained from the regulation by ecosystem processes, including the regulation of climate, water, and some human diseases. Cultural services are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience as well as their role in supporting knowledge systems, social relations, and aesthetic values. Finally, supporting or habitat services are those that are necessary for the production of all other ecosystem services. Examples include biomass production, nutrient cycling, water cycling, provisioning of habitat for species, and maintenance of genetic pools and evolutionary processes.").

45. *See* Barra et al., *supra* note 33, at 35–36, 57; *see also* Christian Gerten et al., *The Sprawling Planet: Simplifying the Measurement of Global Urbanization Trends*, 7 FRONTIERS ENVT'L SCI. 140, 143 (2019) ("The growth of urban land use is a worldwide trend that threatens a range of ecosystem functions through the loss of vegetation and biodiversity, habitat functions, agricultural resources, and soil." (internal citations omitted)).

46. *See* GÓMEZ-BAGGENTHUN & GREN, *supra* note 42, at 176 ("Cities also have disproportionate environmental impacts at the local, regional, and global scales well beyond their borders . . . . Although urbanized areas cover only a small portion of the surface of the planet, they account for a vast share of anthropogenic impacts on the biosphere."). While it is true that, from a global perspective, agricultural land uses have done substantially more ecological damage as a land use category than urban land uses, given their global footprint *See, e.g.*, Barra et al., *supra* note 33, at 57. In the eastern portion of the United States, that relative assessment is different (and less disparate) given the relative growth of urban areas and infrastructure in the region (especially the mid-Atlantic), despite extensive agricultural and natural resource uses. *See* LEE-ASHLEY ET AL., *supra* note 5, at 9 ("The scientific team at CSP found that human activities are causing the persistent and rapid loss of America's natural areas. The human footprint . . . grew by more than 24 million acres from 2001-2017—equivalent to the loss of roughly a football field worth of natural area every 30 seconds."). The footprints of cities, farms roads, power plants, and other human developments in the "South" (where "South" includes more than half of the "mid-Atlantic" region) grew to cover 47% of all land area. And the "Northeast" (which contains the remainder of the mid-Atlantic) saw human activities cover 47.4% of regional land area in that same period. *Id.* at 11.

47. *See supra* notes 36, 46 and accompanying text; *infra* note 53 and accompanying text. For a specific example of how urban expansion degrades local and regional ecosystems, see *Development*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/threats-to-the-bay/development [https://perma.cc/G6J3-TLMV] (last visited July, 29 2023).

48. *See* Masashi Soga et al., *Land Sharing vs. Land Sparing: Does the Compact City Reconcile Urban Development and Biodiversity Conservation?*, 51 J. OF ECOLOGY 1378, 1378–86 (2014), https://doi.org/10.1111/1365-2664.12280 [https://perma.cc/H3N4-LH3Z]; Haaland & Konijnendijk van den Bosch, *supra* note 12, at 760. *See generally* Stephanie Panlasigui et al., *Biophilia beyond the Building: Applying the Tools of Urban Biodiversity Planning to Create Biophilic Cities*. 13 SUSTAINABILITY 2450 (2021), https://doi.org/10.3390/su13052450 [https://perma.cc/UA6U-7EL8].

effectively dismantling local ecosystems. On the one hand, urban expansion in the form of sprawl uses more land and energy inefficiently due to its larger urban footprint, which reduces ecological function and often promotes social inequalities.[49] On the other hand, compact urban densification also has drawbacks — particularly the loss of all kinds of Urban Greenspace[50] that can occur through the process of infill development.[51] At the local and regional level in the mid-Atlantic region of the U.S., this collection of urban growth dynamics and traditional land development practices[52] is damaging natural ecosystems in and around cities and weakening larger ecosystems at the same time.[53] Yet, the health of local ecosystems is fundamental to the success of the urban spaces within them — local ecosystem quality and function determine the extent to which embedded urban areas can access certain essential ecosystem services.[54]

As urban areas degrade regional and local ecosystems, they contribute to, and suffer the loss of, both *global* ecosystem services and crucial *local* ecosystem services as well.[55] In fact, many local ecosystems only provide certain services (like shade, air pollutant removal, and flood management) within certain radii of the ecosystem itself — these benefits are hyper-local, and people must be within range to experience the ecosystem service benefits.[56] Loss of local ecosystem function means reduced water and air

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49. *See* Haaland & Konijnendijk van den Bosch, *supra* note 12, at 760.

50. *Id.* at 761.

51. *See id*. These findings suggest that supporting and strengthening ecosystem function must be pursued and achieved independently from the pursuit of compact urban development. Despite a tendency to confuse the two in much urban planning literature, compact development is not a proxy for ecosystem protection or restoration.

52. By traditional land development practices, I refer to the common practices of clearing land of all vegetation to build, maximizing buildable area on land sites, compacting soils on development sites and destroying natural soil structure, and replacing any remaining vegetation with non-native grasses or hardscaping.

53. *See* Doug Tallamy, *Gardening for Life*, HOMEGROWN NAT'L PARK (2023), https://www.homegrownnationalpark.org/not-in-our-yard-doug-tallamy/ [https://perma.cc/NN3W-AMB8]; *see also* LEE-ASHLEY ET AL., *supra* note 5; *infra* note 58.

54. Urban areas obtain ecosystem services from every scale of ecosystem — from local to regional to global; however, local ecosystems deliver some of the most important ecosystem services to the cities within them, such as heat island management and temperature control, flood and stormwater management, and air pollutant removal. *See generally* Haase et al., *supra* note 38.

55. *Id.* at 414 ("In general, locally generated [ecosystem services] have substantial impacts on the quality of life in urban areas and should, therefore, be more explicitly addressed in conceiving strategies aimed at sustainable development, livability, and resilience in urban milieu." (internal citations omitted)).

56. For example, some studies have determined that trees can only remove air pollutants within a radius of 300 meters. *See* Rob McDonald et al., *Planting Healthy Air*, THE NATURE CONSERVANCY, at 3 (2016),

quality, as well as loss of protection from threats like extreme weather events, including flooding, extreme heat, and disrupted food webs and supply chains.[57] Removing essential ecosystem services not only creates acute, life-threatening emergencies for urban communities when disaster strikes, but these unmitigated threats produce long-term negative effects, including disrupting labor markets, economic development initiatives, subsistence activities, and housing and commercial real estate markets.[58]

The economic costs of ecosystem degradation at the national scale, which will compound as climate change accelerates, are staggering.[59] In 2021, there were 20 weather/climate disaster events with losses exceeding $1 billion each to affect the United States. During the years of 2016-2022, 122 separate billion-dollar disasters killed at least 5,000 people and cost >$1 trillion in damage.[60] Along the East Coast, losses are unsustainable (even if not the worst in the U.S.), with billion-dollar disasters costing in the range of 1-2% of each state's GDP (with the exception of Florida, which is experiencing disasters costing in the range of 7-10% of that state's GDP).[61]

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https://www.nature.org/content/dam/tnc/nature/en/documents/20160825_PHA_Report_Final.pdf [https://perma.cc/KQ8G-GPNV].

57. *See generally* WHITE HOUSE REP., *supra* note 15. Healthy regional ecosystems not only mitigate accelerating climate change and biodiversity loss, but also deliver the ecosystem services humans need to survive and to adapt to extreme weather and other harmful effects of climate change.

58. *See Climate Change*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/threats-to-the-bay/climate-change; *see also* Troy Wegner, *Climate Change*, CHESAPEAKE BAY FOUNDATION (last visited Aug. 15, 2023), https://www.cbf.org/issues/climate-change/index.html; Rebecca Chillrud, *Rising Seas Lead to Rising Costs*, CHESAPEAKE BAY PROGRAM (Mar. 18, 2019), https://www.chesapeakebay.net/news/blog/rising-seas-lead-to-rising-costs [https://perma.cc/6U3R-4D6R]; Catherine Krikstan, *By the Numbers: 128*, CHESAPEAKE BAY PROGRAM (July 26, 2016), https://www.chesapeakebay.net/news/blog/by-the-numbers-128 [https://perma.cc/WQC6-84UD] (fisheries and tourism impact); *Economic Impacts*, CHESAPEAKE BAY TODAY, https://sites.google.com/a/cornell.edu/chesapeake-bay-today/economic-impacts [https://perma.cc/G78J-7WZE] (last visited August 22, 2023).

59. *See* Adam Smith, *2022 U.S. Billion-Dollar Weather and Climate Disasters in Historical Context*, CLIMATE.GOV (Jan. 10, 2023), https://www.climate.gov/news-features/blogs/2022-us-billion-dollar-weather-and-climate-disasters-historical-context [https://perma.cc/Q6YM-AAKB]; *see also* OFF. OF THE PRESIDENT, A ROADMAP TO BUILD A CLIMATE-RESILIENT ECONOMY 7 (Oct. 14, 2021) ("Unless urgent action is taken, climate change will result in significant and negative impacts on the U.S. economy. Increasing disaster recovery costs will continue to undermine the nation's capacity to support and invest in the American people. Rising temperatures and sea levels, extreme floods and increasing droughts, and ecosystem impacts are expected to significantly alter the way we live, grow food, and preserve infrastructure. This will lead to large transformations in economic productivity, global supply chains, and quality of life.").

60. *See* Smith, *supra* note 59 ("One of the drivers of this cost is that the U.S. has been impacted by landfalling Category 4 or 5 hurricanes in five of the last six years, including Hurricanes Harvey, Irma, Maria, Michael, Laura, Ida, and Ian.").

61. *See id.*

2. Rise of Chronic Disease in Cities

Chronic diseases[62] are on the rise in cities. Public health spending on chronic diseases among urban populations is increasing from levels already in the trillions of dollars.[63] 90% of the nation's $4.1 trillion in annual health care expenditures are for people with chronic and mental health conditions.[64] The top five most expensive medical diseases include diabetes, heart disease/stroke, cancer, and obesity,[65] and the majority of these diseases are in the top ten causes of death in the United States.[66] The American Heart

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62. *About Chronic Diseases*, CTRS. FOR DISEASE CONTROL & PREVENTION (July 21, 2022), https://www.cdc.gov/chronicdisease/about/index.htm [https://perma.cc/ERA7-3H57] ("Chronic diseases such as heart disease, cancer, and diabetes are the leading causes of death and disability in the United States. They are also leading drivers of the nation's $4.1 trillion in annual health care costs."); *see also Chronic Disease Rates and Management Strain the US Healthcare System*, LIFESCIENCES INTELLIGENCE (Sept. 6, 2022), https://lifesciencesintelligence.com/features/chronic-disease-rates-and-management-strain-the-us-healthcare-system [https://perma.cc/96AP-ZM86] (Using 2022 data. These diseases, and associated costs, have been steadily rising in the US population" "in 2016, approximately $1.1 trillion was spent on direct costs of chronic disease, with the most significant proportion, 26.7%, being spent on heart disease and cardiovascular conditions.").

63. *See* Wullianallur Raghupathi & Viju Raghupathi, *An Empirical Study of Chronic Diseases in the United States: A Visual Analytics Approach to Public Health*, INT'L J. ENVT'L RSCH. & PUB. HEALTH,1, 2 (Mar. 1, 2018); *see also Chronic Disease Rates and Management Strain the US Healthcare System*, LIFESCIENCES INTELLIGENCE (Sept. 6, 2022), https://lifesciencesintelligence.com/features/chronic-disease-rates-and-management-strain-the-us-healthcare-system [https://perma.cc/96AP-ZM86] ("The rates of chronic disease in the US and the resources required to manage them strains the healthcare system in multiple ways.").

64. *Health and Economic Costs of Chronic Disease*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/chronicdisease/about/costs/index.htm#print [https://perma.cc/KX8Z-7R69] (using data from 2017–2022); Raghupati & Raghupati, *supra* note 63, at 2 ("The top ten health problems in America include heart disease, cancer, stroke, respiratory disease, diabetes, and kidney disease . . . . More than 75% of the $2 trillion spent on public and private healthcare in 2005 went toward chronic disease."); Hayden Schmidt, *Top 10 Most Expensive Chronic Diseases for Healthcare Payers*, HEALTHPAYER INTELLIGENCE (Feb. 22, 2022), https://healthpayerintelligence.com/news/top-10-most-expensive-chronic-diseases-for-healthcare-payers [https://perma.cc/VX9C-TZED]; *see also Chronic Conditions Lead Health Care Spending the U.S.*, UNITEDHEALTHCARE (Apr. 26, 2023), https://www.uhc.com/employer/news-strategies/resources/chronic-conditions-lead-health-care-spend-in-the-us [https://perma.cc/R3CY-EFU4]; *The Most Expensive Medical Diseases and Procedures*, UNIV. S. CAL. EXEC. MASTER HEALTH ADMIN. BLOG, https://healthadministrationdegree.usc.edu/blog/most-expensive-disease-to-treat-infographic/ [https://perma.cc/FTB9-T96N] (top three chronic conditions for expenditures are: heart disease and stroke, cancer, diabetes and prediabetes (using 2022 data)).

65. *See Top 10 Most Expensive Medical Diseases and Procedures*, *supra* note 64, at 5–6.

66. *See Leading Causes of Death*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm#print [https://perma.cc/GM6C-KZ8S] (leading causes of death in 2021 included: heart disease: 695,547, cancer: 605,213, COVID-19: 416,893, accidents (unintentional injuries): 224,935, stroke (cerebrovascular diseases): 162,890; chronic lower respiratory diseases: 142,342; Alzheimer's disease: 119,399; diabetes: 103,294)); *Health and Economic Costs of Chronic*

Association has projected that, by 2035, 45% of the adult population of the United States will have some form of cardiovascular disease.[67] Chronic conditions are particularly challenging to manage because they often occur together (as co-morbid conditions).[68] Six in ten adults in the US have a chronic disease and four in ten adults have two or more.[69] Obesity is particularly dangerous because it is a common co-morbid condition associated with increases in mortality rates and risk for other chronic illnesses, including Type 2 diabetes mellitus, hypertension, high cholesterol, heart disease, stroke, respiratory illnesses, and some cancers.[70] Mental illness is also common in the United States,[71] and can adversely affect the outcomes of other chronic illnesses.[72] Co-morbidities are also expected to increase greatly in the near term.[73] The rise in prevalence and costs of these chronic diseases is of profound medical and financial concern, and it is

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Diseases, *supra* note 64, at 1 ("Nothing kills more Americans than heart disease and stroke. More than 877,500 Americans die of heart disease or stroke every year — that's one-third of all deaths"). Death rates are 37% higher among African Americans than whites[,] and American Indian and Alaska natives have the highest percentage of premature death from CVD. *Adult Health and Nature Fact Sheet*, NAT'L ENV'T EDUC. FOUND. (NEEF), https://www.neefusa.org/sites/default/files/2023-01/NEEF-Adult-Health-and-Nature-Fact-Sheet-2019.pdf [https://perma.cc/WZ97-9A5F] (last visited Aug. 26, 2023) (death rates are 37% higher among African Americans than whites[,] and American Indian and Alaska natives have the highest percentage of premature death from CVD.).

67. *CDC Prevention Programs*, AM. HEART ASS'N (June 5, 2023), https://www.heart.org/en/get-involved/advocate/federal-priorities/cdc-prevention-programs [https://perma.cc/35HJ-5DTC]; *see also* Jean C. Bikomeye et al., *Greenspace, Inflammation, Cardiovascular Health, and Cancer: A Review and Conceptual Framework for Greenspace in Cardio-Oncology Research*, 19 INT'L J. ENVT'L RSCH. & PUB. HEALTH 2426, 2427 (2022) ("In the US, CVD remains the number one cause of death, followed by cancer.").

68. *See* Raghupati & Raghupati, *supra* note 63, at 2.

69. *See About Chronic Diseases*, *supra* note 62.

70. Cardiovascular disease alone affects one in three, or more than 83 million people; more than 60 million Americans have hypertension and high cholesterol, much of which is uncontrolled. *See Adult Health and Nature Fact Sheet*, *supra* note 66 ("More than one third of the population is overweight or obese.").

71. According to the National Institute of Mental Health, estimates suggest that more than one in five U.S. adults live with a mental illness (57.8 million in 2021). *See Mental Illness*, NAT'L INST. OF MENTAL HEALTH, https://www.nimh.nih.gov/health/statistics/mental-illness [https://perma.cc/VZW9-6W4T] (last visited Aug. 26, 2023). Young adults aged 18–25 years had the highest prevalence of mental illness (33.7%) compared to adults aged 26-49 years (28.1%) and aged 50 and older (15.0%). *Id.* The prevalence of mental illness was highest among the adults reporting two or more races (34.9%), followed by American Indian / Alaskan Native (AI/AN) adults (26.6%). *Id.* Adults reporting as White reported at 23.9% and those reporting as Black or African American were measured at 21.4%. *Id.* The prevalence of mental illness was lowest among Asian adults (16.4%). *Id.*

72. *See* Raghupati & Raghupati, *supra* note 63, at 9, 20.

73. *See id.* at 2.

increasingly important to prevent these diseases and reduce treatment costs while maintaining patient outcomes.[74]

B. Urban NT/NBS as a Multi-Faceted Solution

Fostering the presence of Nature in, across, and around cities is an essential approach to reversing current trends and achieving ecosystem and human health.[75] While local ecosystem degradation results in localized ecosystem service losses, the reverse can also be true: local ecosystem restoration can restore local ecosystem services. According to the United Nations, maintaining ecosystem health both within and around cities is essential for " . . . livable, healthy, and resilient cities. Functioning urban ecosystems help clean our air and water . . . . [T]hey also help to support our well-being by shielding us from floods and landslides and providing opportunities for recreation."[76] We can reduce or avoid many of the disasters we are seeing in the U.S. using urban NT/NBS, including Health Forests — a cost-efficient response with broad spectrum benefits that include, but extend beyond, protection from the effects of climate change. Health-focused NT/NBS can be a particularly potent way to regenerate Nature in cities since they can be designed specifically to support regional ecosystems while reducing the burden of chronic disease in urban populations.

It is reasonably intuitive that regional ecosystems require a critical mass of natural areas that support ecosystem function across regional landscapes to operate. It is sometimes less apparent that, as cities take up larger percentage areas of these landscapes, these ecosystems can no longer operate without restoring ecological function to urban land (at least in states where there is insufficient undeveloped land area to support ecosystem function without urban land).[77] Regional ecosystems need more quality, quantity, and

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74. *See, e.g.*, Halsted R. Holman, *The Relation of the Chronic Disease Epidemic to the Health Care Crisis*, 2 ACR OPEN RHEUMATOL 167, 167 (2020) ("Today, chronic disease affects 50% of the population, and its care consumes more than 85% of health care costs. It has become an epidemic."); *see also supra* note 62 and accompanying text.

75. *See* SCIENCE COMMC'N UNIT, UNIV. OF THE WEST OF ENGLAND (UWE), BRISTOL, SCIENCE FOR ENVIRONMENT POLICY FUTURE BRIEF 24: THE SOLUTION IS IN NATURE 5 (2021); *see also* RICARDO BARRA ET AL., UNITED NATIONS ENVIRONMENT PROGRAMME, MAKING PEACE WITH NATURE 4 (2021); WHITE HOUSE REP., *supra* note 15, at 4; Bikomeye et al., *supra* note 11, at 8420–23.

76. UNITED NATIONS ECON. COMM'N FOR EUR., SUSTAINABLE URBAN AND PERI-URBAN FORESTRY: AN INTEGRATIVE AND INCLUSIVE NATURE-BASED SOLUTION FOR GREEN RECOVERY AND SUSTAINABLE, HEALTHY AND RESILIENT CITIES 2 (2021).

77. *See, e.g.*, Andersson et al., *supra* note 36, at 446 ("[S]patial structure [that ensures the integrity of ecological function] becomes a key concern in cities, both as ecological networks and adjoining areas . . . ."). Urban planning for green infrastructure, urban forests, and biodiversity support are increasingly recognized as essential. *See generally* Allred et al., *supra*

connectivity of ecologically functioning landscapes at all scales — and urban lands are essential for filling this need.[78] When designed properly, urban NT/NBS offer high-quality ecological functions, so, if distributed in sufficient quantity and adequate connectivity, they can deliver exactly what regional ecosystems need.[79]

It also may be relatively intuitive that time in nature often makes people "feel better," but less apparent that regular exposure to Nature is essential for human health and that people suffer more chronic disease when they have insufficient access and exposure to Nature.[80] The benefits of NT/NBS and NT/NBS Health Programming are wide ranging but often not well publicized. Research at the intersection of landscape architecture, ecology, physical and occupational rehabilitation, and public health is revealing how these nature exposures and practices produce powerful and reliable health benefits in the human body. [81] Among other things, this research is steadily

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note 26. But these planning efforts are necessarily precursors to the action of allocating lands and expanding land uses that support ecosystem function and health.

78. *See generally* DOUGLAS W. TALLAMY, NATURE'S BEST HOPE: A NEW APPROACH TO CONSERVATION THAT STARTS IN YOUR YARD (2020); Lee A. Dyer et al., *Diversity of Interactions: A Metric for Studies of Biodiversity*, 42 BIOTROPICA 281, 282 (2010); Stephanie Panlasigui et al., *Biophilia Beyond the Building: Applying the Tools of Urban Biodiversity Planning to Create Biophilic Cities*, 13 SUSTAINABILITY 1, 7 (2021); *see also* Amanda J. Zellmer & Barbara S. Goto, *Urban Wildlife Corridors: Building Bridges for Wildlife and People*, 4 FRONTIERS IN SUSTAINABLE CITIES 1, 8 (2022); Robert I. McDonald et al., *Nature in the Urban Century*, NATURE CONSERVANCY (2018); Barra et al., *supra* note 33, at 4. For further explanation of the meaning of "high quality" landscapes from an ecological perspective, see *infra* notes 103–08 and accompanying text.

79. The exact spatial locations for networking Health Forest sites must be determined based on the ecological needs of the ecosystems in and around specific cities. This is why planning for urban green infrastructure and biodiversity can be of vital assistance as stakeholders determine the optimal spatial arrangements for Health Forest networks across urban regions.

80. *See* Stephen K. Van Den Eeden et al., *Association Between Residential Green Cover and Direct Healthcare Costs in Northern California: An Individual Level Analysis of 5 Million Persons*, 163 ENV'T INT'L 107174, 107174 (2022) (discussing significance of improved health outcomes from exposure to high levels of residential vegetation or "green cover"); *see also* Bikomeye et al., *supra* note 11, at 8429–33 ("Public greenspaces have numerous benefits for both physical and mental health, offering resiliency in the face of challenges posed by COVID-19, climate change, structural racism and combating endemic chronic diseases." (internal citations omitted)).

81. Over the last two decades, research has revealed the profound therapeutic effects on the human body of certain kinds of nature experiences, particularly within forests. "During the 1980s, SY [Shinrin Yoku] surfaced in Japan as a pivotal part of preventive health care and healing in Japanese medicine." Margaret M. Hansen et al., *Shinrin-Yoku (Forest Bathing) and Nature Therapy: A State-of-the-Art Review*, 14 INT'L J. OF ENV'T RSCH. & PUB. HEALTH 851, 851 (2017). Due to the numerous positive health effects observed after Shinrin-Yoku, researchers in Asian countries have identified a wide range of physiological effects on the body from forest experiences. *Id.* at 855–84, 887–90; Qing Li, *Effect of Forest Bathing Trips on Human Immune Function*, 15 ENVT'L HEALTH & PREVENTIVE MED. 9, 10, 14–15 (2010). European researchers have recently expanded understandings of the multiple pathways

identifying key therapeutic principles and characteristics of NT/NBS that produce these health benefits. The range of positive effects on the body is quite striking: NT/NBS and NT/NBS Health Programming ameliorate many chronic diseases along a spectrum of intervention points from general wellness and prevention to treatment to rehabilitation and recovery.[82]

Health benefits of NT/NBS include: direct mitigation of the negative environmental effects of ecosystem degradation (e.g., reducing exposures to harmful contaminants that cause chronic disease);[83] mitigation of environmental conditions that aggravate pre-existing medical conditions (e.g., extreme heat);[84] and healing the body in ways that prevent or treat

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through which nature protects and heals us. Marja I. Roslund, *Long-Term Biodiversity Intervention Shapes Health-Associated Commensal Microbiota Among Urban Day-Care Children*, 157 ENV'T INT'L 106811, 106811 (2021). And, recently, the field of nature-health intersections has entered the mainstream of public health conversations in the United States. *See generally* Jenifer Frank, *Medical Providers Are Taking Nature Therapy Seriously*, CONN. HEALTH INVESTIGATIVE TEAM (Feb. 22, 2021), https://c-hit.org/2021/02/22/medical-providers-are-taking-nature-therapy-seriously/ [https://perma.cc/MJD6-H8RM]. The following studies, compiled by Hansen et al., provide examples of the beneficial health effects of nature-based health practices: (i) A Shinrin Yoku study revealed an "80% increase in the parasympathetic indicators of heart rate variability" while in the forest; blood pressure and pulse rate decreased while in forest settings compared to urban settings; (ii) In a randomized control study of 24 adults with hypertension, a week-long trip to a nature setting showed a decrease in blood pressure and heart disease-related pathological factors: the NT decreased the renin-angiotensin system, which helped manage hypertension; (iii) In 20 adult patients with coronary artery disease, cardiac function improved after a week of 30-minute sessions in nature; (iv) 20 patients diagnosed with chronic obstructive pulmonary disease experienced a decrease of perforin and granzyme B expressions accompanied by decreased levels of pro-inflammatory cytokines and stress hormones after two forest bathing walks over the course of one day; (v) In a longitudinal study of 48 adults diagnosed with Type 2 diabetes mellitus, blood glucose readings declined after multiple Shinrin Yoku practice sessions; (vi) 71 men and women reported a statistically significant correlation between improved general sleep-wake cycles and 2-hour forest walks over the course of 3 months. Hansen et al. at 885–87. For a lay summary of these propositions, see FRANCES E. (MING) KUO, PARKS AND OTHER GREEN ENVIRONMENTS: ESSENTIAL COMPONENTS OF A HEALTHY HUMAN HABITAT 3–4 (2010) ("[D]o people living in greener neighborhoods have better health outcomes when we take income and other advantages associated with greener neighborhoods into account? The answer is yes. Yes, the benefits of nature that have been intuited and written about through the ages have withstood rigorous scientific scrutiny. . . . In the face of the tremendously diverse and rigorous tests to which the nature-human health hypothesis has been subjected, the strength, consistency, and convergence of the findings are remarkable.").

82. *See supra* note 19 and accompanying text; *supra* Section I.B (Urban NT/NBS as a Multi-Faceted Solution); Litman, *supra* note 10, at 35, 43.

83. *See, e.g.*, Danielle F. Shanahan et al., *The Health Benefits of Urban Nature: How Much Do We Need?*, 65 BIOSCIENCE 476, 476 (2015) ("Nature functions in ways that alter the physical environment that people live in, thereby reducing health risks; these are called biophysical ecosystem services. For example, vegetation can filter pollutants from the air and buffer the urban heat island effect, potentially reducing the prevalence of respiratory infections or heat-related illnesses." (internal citations omitted)).

84. *See, e.g.*, *Extreme Heat: Staying Safe if You Have Health Issues*, HARVARD HEALTH PUBLISHING, https://www.health.harvard.edu/blog/extreme-heat-staying-safe-if-you-have-

certain chronic diseases and disease risk factors regardless of the underlying causes of the disease or risk factor (e.g., reducing cortisol levels and improving heart rate variability).[85] Hansen et al. described NT/NBS's therapeutic effects on: (1) immune system function (including improved Natural Killer Cell function[86]), (2) cardiovascular system function, (3) respiratory system function, (4) depression and anxiety, and (5) mental relaxation, attentional, and related disorders, as well as sleep cycles.[87] NT/NBS can also lower blood sugar, improve concentration, diminish pain, and improve immunity.[88]

Specifically, NT/NBS have substantial positive effects in the prevention and treatment of medical disorders like hypertension, heart disease, obesity,

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health-issues-202108062563 [https://perma.cc/X3MT-P5TP] (discussing chronic conditions that require additional precautions in extreme heat: Extreme heat can disturb the balance of essential minerals in the blood known as electrolytes for many people with chronic illnesses (especially of the heart and kidneys) or diabetes. When this occurs, a person may feel fatigue, nausea, or a headache. In extreme instances, heart attack, irregular heart rhythms (arrhythmia), or problems with other organs may occur. Data from millions of people enrolled in Medicare show that hospital admissions during heat waves lasting two or more days are most often due to heat stroke, sunstroke, fluid and electrolyte imbalances, and acute kidney failure); *see also* Isabella Cueto, *It's Not Just Heat Stroke. Extreme Temperatures Pose Special Risk to People with Chronic Illness (and That's a Lot of Us)*, STAT, https://www.statnews.com/2022/07/19/heat-waves-risk-to-people-with-chronic-illness/ [https://perma.cc/CUL3-3C2D].

85. *See supra* notes 80–82 and accompanying text.

86. *See* Hansen et al., *supra* note 81, at 851; Li, *supra* note 81, at 11.

87. *See* Hansen et al., *supra* note 81, at 851, 868, 876; *see also* Van Den Eeden et al., *supra* note 80, at 107174 (summarizing numerous studies that reflect a wide range of health benefits from exposure to nature).

88. *Forest Therapy*, FOREST THERAPY ASS'N OF THE AMERICAS, http://forest-therapy.net/foresttherapy.html [https://perma.cc/28ZK-873P] (last visited July 23, 2023); Hansen et al., *supra* note 81, at 851–56, 886; Geoffrey H. Donovan et al., *Association Between Exposure to the Natural Environment, Rurality, and Attention-Deficit Hyperactivity Disorder in Children in New Zealand: a Linkage Study*, 3 THE LANCET PLANETARY HEALTH e226, e226 (2019). Health studies beyond Shinrin Yoku that show substantial health effects include: (a) A longitudinal study of children in New Zealand found that exposure to minimum levels of greenness between ages 2-18 was strongly and independently associated with a reduced risk of ADHD; (b) 12 men took a two-night trip to a forest in Nagano Prefecture in 2006, including three leisurely strolls and a hotel stay in the woods, and 13 female nurses made a similar trip in 2007. Natural killer cell activity was boosted in both groups, and the increase was observed 30 days later. Increase in NK activity can be attributed partly to inhaling air containing phytoncides, or wood oils given off by plants; (c) Treatment groups attended (i) urban day care centers where their yards were covered with forest floor and sod (i.e., daily exposure), or (ii) nature-oriented day care centers where children visited nearby forests on a daily basis. The intervention caused a long-standing increase in beneficial bacteria and lower than baseline presence of harmful bacteria in children's micro-biomes, which is associated with healthy immune regulation and protection from allergies, asthma, diabetes and auto-immune diseases. *Forest Therapy*; Roslund, *supra* note 81, at 106811–12 (citing generally Marja I. Roslund et al., *Biodiversity Intervention Enhances Immune Regulation and Health-Associated Commensal Microbiota Among Daycare Children*, 130 ENV'T INT'L 104894 (2020)).

Type 2 diabetes mellitus, allergies in children, auto-immune diseases, post-surgical recovery and psychosocial conditions like depression, chronic stress, post-traumatic stress disorder (PTSD), and attention deficit hyperactivity disorder (ADHD).[89] Based on my research interviews, chronic diseases that are extremely responsive to NT/NBS and NT/NBS Health Programming include cardiovascular disease (CVD), hypertension, mental illness (particularly depression and anxiety), and attentional disorders (ADD and ADHD).

The health benefits are so remarkable that numerous stakeholders, including government agencies, environmental nonprofits, landscape architects, educators, public and mental health advocates, and public park advocates, have started to study and design programs that use these human-nature connections to promote human health — and to treat or support recovery from certain diseases or injuries. For example, practitioners and researchers around the world have begun experimenting with: (a) rehabilitation gardens, like the Stenzel Healing Garden at Legacy Hospital for stroke patients; [90] (b) camping/hiking in wilderness areas for victims of physical trauma [91] and military veterans;[92] (c) prescriptions to exercise in public parks (Park Rx America);[93] (d) areas with nature and spiritual features combined;[94] (e) forest-bathing trails and guided meditation walks in nature, often modeled on the Japanese practice of Shinrin Yoku;[95] (f) nature play

89. Roslund, *supra* note 81, at 106812; Roslund, *supra* note 88, at 104894; Hansen et al., *supra* note 81, at 851. *See generally* Wolf et al., *supra* note 13.

90. *Therapeutic Gardens*, LEGACY HEALTH, https://www.legacyhealth.org/services-and-resources/services/adult/horticultural-therapy [https://perma.cc/VGE3-54MV] (last visited Aug. 19, 2023).

91. The Willamette Partnership (WP) offers outdoor excursions (camping trips) specifically designed for people who have suffered physical trauma or permanent disability: WP provides an opportunity for people with disabilities to reconnect with nature in a safe context with the kind of support they need to enjoy camping again. *See Outdoor Equity for a Healthier Region*, OR. HEALTH & OUTDOORS INITIATIVE, https://www.healthandoutdoors.org [https://perma.cc/HF6A-THG4] (last visited July 24, 2023).

92. *See VOAG Coalition*, VETERANS' OUTDOOR ADVOCACY GRP., https://www.voag.org/voag-coalition [https://perma.cc/79KT-DZ36] (last visited July 24, 2023).

93. *ParkRx: PRA Nature Prescribed*, WASH. STATE PARKS, https://www.parks.wa.gov/1137/ParkRx [https://perma.cc/FM9V-45QG] (last visited Aug. 20, 2023); *Our Vision*, PRA NATURE PRESCRIBED, https://parkrxamerica.org/about/vision.php [https://perma.cc/KCP2-E5U6] (last visited Aug. 20, 2023).

94. *What are Sacred Places*, NATURE SACRED, https://naturesacred.org/our-work/product-design/ [https://perma.cc/X6TU-US87] (last visited Aug. 20, 2023).

95. *See Experience Forest Therapy Walks Remotely Guided or In-Person with ANFT Certified Forest Therapy Guides*, ASS'N. NATURE & FOREST THERAPY, https://www.natureandforesttherapy.earth/virtual-forest-therapy-walks [https://perma.cc/8WSC-HZNH] (last visited Aug. 20, 2023); *Nature Worx: Explore. Connect. Thrive.*, NATUREWORX, https://www.natureworx.org [https://perma.cc/U42L-

spaces for kids (generally at schools);[96] and (g) outdoor areas for patient support groups and family recuperation[97]. And professionals across the nursing, public health, physical rehabilitation, and landscape design sectors continue to experiment with NT/NBS Health Programming — despite gaps in published medical research on the topic — because these robust connections promote health, prevent and heal illness, and enrich people's lives.[98]

As more people move to cities, having easy access to NT/NBS can ensure adequate and appropriate levels of exposure — *if* people make more space for them within city borders. Incorporating Nature back into urban areas does not require displacing people from those same areas if we learn to share the space for mutual benefit, but doing so requires designing for mutual benefit, setting measurable goals, and building in accountability to ensure the space strengthens ecosystems while it improves human health.[99] To do

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7YZZ] (last visited Aug. 20, 2023). Shinrin Yoku is the Japanese practice of forest bathing, an activity that involves walking through forests. Ian Banyard, *The Origin of Forest Bathing & Forest Therapy*, COTSWOLD NAT. MINDFULNESS & FOREST BATHING (Mar. 10, 2019), https://www.ianbanyard.com/home/the-origin-of-forest-bathing-forest-therapy/ [https://perma.cc/3GVH-PSMY]. In the practice, one intentionally immerses oneself in nature by mindfully using all five senses. Hansen et al., *supra* note 81, at 1–2. This was popularized in Japan by Tomohide Akiyama of the Japanese Ministry of Agriculture, Forestry, and Fisheries in 1982. The term Shinrin Yoku itself invokes the interconnectedness of forests and the luxury of being fully engulfed in the abundance of the forest. It is based in the belief that humans have, or can cultivate, a deep connection to (and understanding of) nature that is healing. The practice harkens back to Shugendo Buddhist priests, or Yamabushi, of the eighth century who believed that the highest truth exists in nature and that people can access this trust better through immersion in the power and strength of the natural world. Julia Plevin, *From Haiku to Shinrin-Yoku: A Brief History of Forest Bathing*, FOREST HIST. TODAY, 17, 17 (2018).

96. *Health and Environment*, THE NAT'L ENV'T EDUC. FOUND. (NEEF), https://www.neefusa.org/explore/health-and-environment [https://perma.cc/9LNN-SNN8] (last visited July 18, 2023); *Green Schoolyards America*, GREEN SCHOOLYARDS AM., https://www.greenschoolyards.org/news/2016/7/14/the-green-schoolyard-movement-gaining-momentum-around-the-world [https://perma.cc/LVL7-QLTG] (last visited July 18, 2023). WP promotes the use of outdoor classrooms, particularly among pre-school aged children. *See* WILLAMETTE P'SHIP., https://willamettepartnership.org/outdoor-preschool/ [https://perma.cc/Q7PU-VDZB] (last visited July 18, 2023).

97. *The Green Road at Walter Reed National Military Medical Center*, NATURE SACRED, https://naturesacred.org/sacred_place/the-green-road/ [https://perma.cc/2H8W-RECR] (last visited Aug. 20, 2023).

98. *See, e.g.*, Bratman et al., *Nature and Mental Health*, *supra* note 7; Hartig et al., *supra* note 12. In addition to support in the academic literature, this statement was evidenced quite clearly in the range of interviews I conducted as part of my research. *See infra* App'x A–B.

99. *See, e.g.*, Sara Meerow, *A Green Infrastructure Spatial Planning Model for Evaluating Ecosystem Service Tradeoffs and Synergies across Three Coastal Megacities*, 14 ENV'T RSCH. LETTERS 1, 9 (2019), https://iopscience.iop.org/article/10.1088/1748-9326/ab502c [https://perma.cc/V5V2-GQD7] (designing urban green infrastructure for ecosystem service synergies); Fushcia-Ann Hoover & Matthew E. Hopton, *Developing a Framework for Stormwater Management: Leveraging Ancillary Benefits from Urban*

this, urban professionals need to maximize synergies and features that simultaneously deliver health and ecological benefits, but these synergies and features aren't present in all Urban Greenspaces.[100] NT/NBS are particular types of Urban Greenspace and should be intentionally developed with specific combinations of features, including NT/NBS Health Programming, in order to get the maximum range of benefits (which is essential for financial feasibility). These features are outlined in Part II.

II. THE SPECIAL SAUCE: ESSENTIAL FEATURES FOR MAXIMUM ECOLOGICAL AND HEALTH BENEFIT

We can use NT/NBS to address ecosystem degradation and chronic disease, but not any Urban Greenspace will do: there is a "special sauce" — there are certain features that make ecosystems healthy by supporting ecosystem function, and certain features that make nature experiences therapeutic. Ensuring these features are present, and *maximizing the synergies among them*, will make all the difference to success or failure. The following two sections summarize and synthesize my research findings about the key features and characteristics of NT/NBS that make them highly effective at achieving both environmental and health objectives (including necessary operational requirements related to NT/NBS Health Programming). From this, I articulate a vision of optimized urban NT/NBS specifically designed for, and operated in, cities — Health Forests — to address chronic disease and ecosystem degradation at scale in ways that can be funded, at least in part, by the private sector.

A. Essential Features for Maximum Ecosystem Health Benefit

Although traditional urban development dismantles key drivers and indicators of ecosystem health, this trend can be reversed with careful

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Greenspace, 22 URB. ECOSYSTEMS 1139, 1140 (2019) (leveraging co-benefits of stormwater green infrastructure); *see also* Soga et al., *supra* note 48, at 1378.

100. *See, e.g.*, Christopher A. Lepczyk et al., *Biodiversity in the City: Fundamental Questions for Understanding the Ecology of Urban Green Spaces for Biodiversity Conservation*, 67 BIOSCIENCE 799, 800 (2017) (with respect to biodiversity support and related benefits: "evidence drawn from ecological theory and empirical data suggests that not all green spaces have equal value. In some cases, urban green spaces provide only limited biodiversity benefits, although the evidence base with which to assess the benefits of different forms of urban environmental management is often limited. Thus, designing management and restoration plans or advocating for habitat features in urban green spaces often does not make full use of the science that is available, even though that science is itself limited. Identifying the ecological role and conservation value provided by different types of urban green spaces is of particular importance given the continued growth of urban areas, the development of new cities, and the promotion of certain types of green spaces . . . ." (internal citations omitted)).

planning, design, and implementation of urban NT/NBS.[101] For NT/NBS to strengthen ecosystems while promoting health, their design and management must prioritize and be fundamentally integrated with the key drivers and indicators of ecosystem health specified below. Drivers and indicators of ecosystem health ensure that a space *strengthens* local and regional ecosystems because they give Nature what it needs to thrive.[102] At the site scale, these key drivers and indicators[103] are: (i) biological and genetic diversity (biodiversity);[104] (ii) interaction diversity;[105] (iii) structural diversity;[106] (iv) regular cycling of materials and energy through the system;[107] and (v) clear generational succession — meaning species are producing new generations that succeed the existing individuals — all of which enable resilience in the face of disturbance. Such features ensure that the space is *high quality* from an ecological perspective.

At the regional level, as noted above in Section I.B, ecosystems need: improved quality greenspace, increased quantity of high-quality greenspace,

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101. *See Nature in the Urban Century*, THE NATURE CONSERVANCY (Nov. 13, 2018), https://www.nature.org/en-us/what-we-do/our-insights/perspectives/nature-in-the-urban-century/ [https://perma.cc/RY52-4FX3]. Although this Article focuses specifically on NT/NBS, urban Nature can be strengthened with a range of approaches that use Nature-Based Solutions, conserve and manage protected areas near cities for ecological value, and re-integrate native habitat into public and private lands. *See id.*

102. *See Urban Nature-Based Solutions*, WORLD WIDE FUND FOR NATURE, at 3, https://wwf.panda.org/projects/one_planet_cities/what_we_do/urban_naturebased_solutions/ [https://perma.cc/T3H2-6BHF] (last visited July 18, 2023).

103. This list of features is one that I created based on literature reviews that examine ecosystem function and urban greenspaces. *See, e.g.*, Norman L. Christensen, et al., *"The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management,"* 6 ECOLOGICAL APPLICATIONS 665, 671–72 (1996); Britta L. Timpane-Padgham, et al., *A Systematic Review of Ecological Attributes that Confer Resilience to Climate Change in Environmental Restoration*, 12 PLOS ONE e0173812, e0173816–20, e0173822 (2017).

104. *See* TALLAMY, *supra* note 78, at 109.

105. Interaction diversity is determined in terms of the amount of species interactions, such as: do they feed off each other, use each other to reproduce, or support each other's health. *See id.* Interaction diversity heavily depends on whether the animal and plant communities have co-evolved together. *See id.*

106. Structural diversity considers the importance of having different species (or species of different ages) occupy different areas or niches within the space), and includes vertical structure (e.g., different plant species and other structural elements of an ecosystem occupying different heights). *See, e.g.*, RICK DARKE & DOUG TALLAMY, THE LIVING LANDSCAPE: DESIGNING FOR BEAUTY AND BIODIVERSITY IN THE HOME GARDEN 17 (2014) (reviewing the "inherent organization" and vertical layers of a deciduous forest); *see also* Timpane-Padgham et al., *supra* note 103, at 8 (noting that structural diversity and complexity incorporates refugia required for resilience).

107. An example of cycling of matter and energy is the decomposition of organic matter such as "leaf litter" by microorganisms that cycle nutrients in ways that contribute to soil and plant health. *See supra* note 42 (discussing ecosystem services).

and connectivity among those high-quality greenspaces.[108] Connectivity of natural areas (which may be structural or functional)[109] is particularly important. "Ecological networks for conservation are more effective in achieving biodiversity conservation objectives than a disconnected collection of individual protected areas . . . because they connect populations, maintain ecosystem functioning and are more resilient to climate change."[110] This is why networks of structurally or functionally connected NT/NBS provide the maximum ecological benefit to an urban region.

B. Essential Features for Maximum Human Health Benefit

Maximizing health benefits from NT/NBS — while maximizing ecosystem benefits — is critical. As discussed further in Part III, it is not only important to maximize health benefits for the sake of improving patient outcomes, but also, in order for the private sector to invest in and activate a new "micro-economy" around urban NT/NBS that can render NT/NBS financially sustainable. In other words, the NT/NBS will need to achieve sufficient reductions in healthcare costs (using methods that are more cost-effective than conventional treatments) so that NT/NBS can become desirable investments for healthcare payers and other investors who can monetize such cost savings. This Section reviews what it takes for NT/NBS to achieve optimal health benefits (while preserving key features for ecosystem health), so that the health benefits they deliver can produce high-quality health outcomes *and* financial benefits for investors.

Scientists have not yet definitively determined how or why NT/NBS have such beneficial effects on the body, but there are a number of scientifically supported hypotheses about the pathways and mechanisms underlying the nature-body connection:[111] (i) reduced exposure to pollution or extreme

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108. *See* Lepczyk et al., *supra* note 100, at 803; Zellmer & Goto, *supra* note 25, at 2, 8.

109. For definitions of these terms see *Connectivity Planning*, CONSERVATION PLANNING IN THE HUDSON RIVER ESTUARY WATERSHED, https://hudson.dnr.cals.cornell.edu/conservation-planning/inventory-and-planning/connectivity-planning [https://perma.cc/C5NJ-DVZC] (last visited July 18, 2023) ("Structural connectivity considers the physical characteristics that support or impede a connected natural landscape"; "Functional connectivity describes how well a landscape allows for movement of organisms and processes such as seed dispersal, breeding migrations, and genetic exchange.").

110. Jodi Hilty et al., *Guidelines for Conserving Connectivity Through Ecological Networks and Corridors*, 30 BEST PRAC. PROTECTED AREA GUIDELINES SERIES 1, 15 (2020).

111. *See generally* Wolf et al., *supra* note 13 (scoping review of studies examining relationships between urban trees and human health); *see also* Terry Hartig et. al., *Tracking Restoration in Natural and Urban Field Settings*, 23 J. OF ENV'T PSYCH. 109, 109 (2003). Studies that hypothesize about the pathways and mechanisms by which nature has health effects on the body have been evolving in the United States since the 1980s, and different

weather;[112] (ii) increased physical activity;[113] (iii) exposure to phytoncides;[114] (iv) stress reduction/parasympathetic activation[115] (v) attentional restoration and noise avoidance;[116] (vi) increased social cohesion;[117] (vii) exposure to biodiversity[118]; and (viii) biophilic responses.[119] Some of these pathways require programming or community effort to succeed (e.g., social cohesion must be cultivated in the space). Given the substantial range of effects on the body, there are likely additional pathways: in fact, new potential pathways and nuances are being discovered as more studies emerge in the academic literature. Such new pathways may include the effects of animal sounds, like bird song, on our nervous system.[120]

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schools of thought have emerged, as scientific research has expanded. A comprehensive review of these hypotheses is beyond the scope of this article; however, I have listed the broad categories under which most theories fall.

112. *See, e.g.*, Wolf et al., *supra* note 13, at 4371, 4378–79 (discussing studies of air pollutant removal and lower prevalence of asthma due to efforts to mitigate extreme heat).

113. *See id*. at 14 (discussing increased physical activity benefits associated with urban tree cover and greenspace).

114. *See* Li, *supra* note 81, at 9–10, 12.

115. *See* Bratman et al., *Nature and Mental Health*, *supra* note 7, at 2–3, 6.

116. *See id*. at 5 ("Although much of the research literature defaults to eyesight as the primary modality for nature contact, the auditory, tactile, and olfactory modalities are also important to consider."); Hartig et al., *supra* note 12, at 216 ("First, natural areas and features can reduce exposure to challenging environmental conditions by increasing distance to stressors and/or decreasing their perceptual salience. For example, green spaces between residences and heavily trafficked roads can reduce occupant noise annoyance, vegetation can conceal displeasing structures, and landscaping around housing can help residents maintain privacy and avoid feelings of crowding." (internal citations omitted")).

117. *See* Wolf et al., *supra* note 13, at 4371, 4386; *see also generally Where Does Community Grow?: The Social Context Created by Nature in Urban Public Housing*, 29 ENV'T & BEHAV. 468 (1997).

118. *See* Roslund et al., *supra* note 81, at 1, 10. One of the most recent hypotheses to emerge in the literature is the "biodiversity hypothesis," which may have profound implications for the relative importance of choosing Health Forests over other urban nature experiences. The biodiversity hypothesis states that physical contact with unpolluted, biodiverse natural environments enriches the chemical and hormonal processes of the human body — specifically with respect to the human microbiome, and that these interactions promote healthy balance in the immune system and long-term protection from allergies and inflammatory disorders. *See* Tari Haahtela et al., *Immunological Resilience and Biodiversity for Prevention of Allergic Diseases and Asthma*, 72 ALLERGY, EUR. J. OF ALLERGY & CLINIC. IMMUN. 3613, 3614, 3623 (2021).

119. *See* WILLIAM D. BROWNING, ET AL., THE ECONOMICS OF BIOPHILIA 6–7 (2015), https://www.terrapinbrightgreen.com/reports/the-economics-of-biophilia/ [https://perma.cc/LHJ4-9DFZ].

120. *See It's True: The Sound of Nature Helps Us Relax*, SCIENCEDAILY (Mar. 30, 2017), https://www.sciencedaily.com/releases/2017/03/170330132354.htm [https://perma.cc/X32M-3N7P]; *see also* Raf Aerts et al., *Biodiversity and Human Health: Mechanisms and Evidence of the Positive Health Effects of Diversity in Nature and Green Spaces*, 127 BRIT. MED. BULLETIN 5, 6 (2018).

Because many varied mechanisms appear to act on, and operate within, the body, we are most likely to optimize the effects of NT/NBS when the space can activate as many potential mechanisms as possible simultaneously[121] (except to the extent they interfere with each other, or with medically accepted non-NT/NBS treatments, or to the extent they aggravate existing medical conditions of the individual patient). In my research, I found that the 4 most important features[122] for optimal health outcomes are:[123]

1. The dose of nature exposure (i.e., the extent of biodiverse Nature present in terms of quality and quantity, *and* the length of time an individual is exposed in the space); [124]

2. The geographic proximity of the NT/NBS to participants (i.e., the nature space must be physically close by and easy to access for the individual);

3. The frequency of exposure over time (i.e., how often a person returns to the nature space for exposure); and

4. An individual's subjective experience of the Nature in the NT/NBS, and whether there is NT/NBS Health Programming during visits.

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121. *See* Van Den Eeden, et al., *supra* note 80, at 7 ("[I]f green space confers health benefits, it is likely through effects across multiple organ systems and chronic diseases (with some as yet unstudied or recognized)."); *see also* Ming Kuo, *How Might Contact with Nature Promote Human Health? Promising Mechanisms and a Possible Central Pathway*, 6 FRONTIERS IN PSYCH. 1, 2–4 (2015).

122. The academic study of these features is evolving, as is the terminology used to describe and categorize them. *See* Bratman et al., *Nature and Mental Health*, *supra* note 7, at 1, 3–6. Nature "dose" terminology, in particular, may vary across authors. *See generally* Shanahan, et al., *supra* note 10 (exploring definitions of nature "dosages," examining threshold dosages for health outcomes, and treating frequency, duration, and intensity of nature exposures as components of "dosage").

123. These four factors interact with each other to determine total health efficacy of nature experience: for example, a very small dose of nature exposure might require increased frequency of exposure to maintain a health effect. *See* Toker Thesis, *supra* note 19, at 30 (noting these interactions but explaining that these relationships have not yet been quantified in literature or by the research interviewees).

124. Different research studies define "dose" differently: Shanahan et al. use the terms "intensity" and "duration" in lieu of the term "dose" as used in this Article; and they define the term "dose" to include intensity, duration, *and* frequency. *See* Shanahan, et al., *supra* note 10, at 1. Unfortunately, the academic community has not arrived at globally accepted meanings for terms like "dose," "intensity," and "frequency" with respect to nature-based health practices.

1. Nature Exposure/Dose: Design/Nature Context & Session Duration

Research interviews[125] indicated that optimal "dose" is achieved in NT/NBS when the spaces are characterized by the following: (i) sensory immersion and visual complexity (without over-stimulation); (ii) space enables focused attention and "presence" (i.e. removal of distractions);[126] (iii) abundance of Nature; (iv) biodiversity/species richness; (v) space produces a sense of awe, fascination, or peace; (vi) space encourages appropriate activity/exertion level for target illness; and (vii) fresh air and thermal tolerance. These kinds of experiences will depend on two major components of any given nature exposure: (a) design/nature context and (b) session duration. [127] With regard to design or nature context, while a wide array of "natural" settings are currently used for NT/NBS in practice, [128] my research strongly suggests that the optimal setting is NT/NBS that are characterized by robust drivers and indicators of ecosystem health (discussed in *infra* Part II.A). The drivers and indicators of ecosystem health that support the healthy functioning of local ecosystems also support optimal dose, provided the requirements for a positive subjective experience are satisfied (discussed *infra* Section II.B.4). For example, more vegetation abundance (e.g., greater forest tree stand density) and greater species

125. *See* Toker Thesis, *supra* note 19, at 31 n.9 (personal communications with AR1, AR2, P2, and P4, in addition to literature review); *infra* App'x A (appendices below describe the interviewees referenced throughout this Article, which are further described in the Toker Thesis); *see also Design Elements*, NATURESACRED, https://naturesacred.org/our-work/product-design/ [https://perma.cc/5MN7-GLDK] (last visited Aug. 8, 2023).

126. *See* Toker Thesis, *supra* note 19, at 31 n.10 ("P2 emphasized the need for a sense of 'being away' from stress 'triggers' (e.g., distractions or stressors from daily life that draw one back into thoughts about one's illness or that induce a recurrence of the illness itself)."); *infra* App'x A; *see also* Hartig et al., *supra* note 111, at 110 (citing the Attention Restoration Theory argues that the experience of "being away" is essential for health).

127. *See* Toker Thesis, *supra* note 19, at 31. Although a sense of safety is essential, the relative importance of an experience of "peace" or "calm" in the space likely depends on a combination of the disease at issue, the individual's sensitivities, and the amount of stimulation that individual requires in order to achieve a state of "presence" — in some cases, more adventure and activity (even at the expense of peace and calm) may be more beneficial. *See, e.g.*, VETERANS OUTDOOR ADVOC. GRP., https://www.voag.org [https://perma.cc/2UDA-DJ4T] (last visited Aug. 8, 2023); *see also* Dustin Jones, *New VA Program Investigates Outdoor Therapy for Veterans*, NPR (Jan. 27, 2021, 5:00 AM), https://www.npr.org/2021/01/27/958138926/new-va-program-investigates-outdoor-therapy-for-veterans [https://perma.cc/B6P5-NBRQ].

128. My interviewees suggested that the kind of nature that can be effective for health treatment is wide-ranging and can have highly beneficial effects in many designs. *See* Toker Thesis, *supra* note 19, at 31 n.8; *infra* App'x A; Hartig et al., *supra* note 12, at 210–11 (research studies examining nature-health relationships have studied the effects of "nature" in this wide range of forms, all of which appear to benefit people either in experiments or anecdotally in practice).

richness have greater positive health effects on the body, [129] particularly when paired with NT/NBS Health Programming. The NT/NBS need to be of sufficient size to accommodate essential features and activities, but small parcels are often sufficient (discussed *infra* Section II.C.2). Achieving maximum overlap between features that maximize ecological health and features that maximize human health in the NT/NBS may require NT/NBS Health Programming to ensure a positive subjective experience (see *infra* Sections II.B.4, II.C.4), but it can be done.

Session duration (e.g., length of exposure to the NT/NBS) is also a key variable for dose — people must spend a certain amount of time in the NT/NBS during a visit for maximum benefit.[130] In my interviews, practitioner opinions on the minimum and optimal therapeutic length of exposure in (or duration of) a NT/NBS visit was wide ranging: AR1 emphasized that optimal duration of exposure will vary with age and preexisting disease/health state.[131] P2 led therapy practices over two-to-three-day periods and suggested that at least two-hour durations were helpful for optimal health benefits. AR1 stated that a minimum 20-minute duration was normally essential.[132] Shanahan et al. state that an NT/NBS duration of at least 30 minutes per week is necessary to obtain health benefits.[133] Other research studies suggest that longer durations are more restorative: Scopelliti et al. explain that the restoration process may proceed through several stages (e.g., "ranging from clearing one's mind to renewing directed attention mechanism, to possibility for reflection on personal issues").[134] Therefore, an individual's length of time in a space may vary but should exceed short bursts of exposure (e.g., five to ten minutes) [135] and exclude time multi-tasking while in the space.

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129. *See* Wolf et al., *supra* note 13, at 4382; *see also* Emma Wood et al., *Not All Green Space is Created Equal: Biodiversity Predicts Psychological Restorative Benefits from Urban Green Space*, 9 FRONTIERS IN PSYCH. 1, 8– 9 (2019). Some research suggests there may be upper limits to the amount of species abundance or vegetation density that promotes therapeutic nature experiences, though this threshold will be intensely affected by subjective understandings of species abundance and the NT/NBS Health Programming used in the space. *See, e.g.*, Shanahan et al., *supra* note 10, at 4; *see also infra* Section II.C.4 (Health Forests).

130. *See* Toker Thesis, *supra* note 19, at 30–32.

131. *See id.* at 31.

132. *See id.*

133. *See* Shanahan et al., *supra* note 10, at 2–3; *see also* Mary Carol R. Hunter et al., *Urban Nature Experiences Reduce Stress in the Context of Daily Life Based on Salivary Biomarkers*, 10 FRONTIERS IN PSYCH. 1, 5 (2019) (salivary cortisol and relationship to duration of exposure — with maximum benefits occurring during 20-30 minutes of exposure).

134. *See* Massimiliano Scopelliti et al., *Is It Really Nature That Restores People? A Comparison With Historical Sites With High Restorative Potential*, 9 FRONTIERS IN PSYCH. 1, 3 (Jan. 2019).

135. Although the balance of my research suggested that exposures longer than five to ten minutes are most beneficial, there are findings that raise questions as to whether longer

2. Location/Access: Proximity

Geospatial relationships have important effects on the magnitude of the health benefit from time in Nature. "Cross-sectional and longitudinal research has found that the psychological well-being of a population can be associated, in part, with its proximity to green space, blue space . . . and street trees or private gardens in both urban and rural settings."[136] Proximity is important for at least two reasons: first, for ecosystem services that are delivered only within a certain range of the biophysical ecosystem (e.g., pollutant reduction; heat island mitigation), people must be located within that range.[137] Second, proximity to the NT/NBS supports frequency of use.[138] If a NT/NBS is difficult or time consuming to access, whether because of distance or other physical impediments, many people will reduce or stop their visits to the space.[139] In fact, for some individuals, distance or physical barriers may make the space impossible for them to access without third-party assistance (financial or physical) and prevent such individuals from gaining health benefits from the space (including the hyper-localized benefits, like air quality improvement, one gets from being proximate to the space even without entering it).[140]

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periods of time are better or necessary, especially when engaging in physical activity. *See generally* Toker Thesis, *supra* note 19; Jo Barton & Jules Pretty, *What Is the Best Dose of Nature And Green Exercise for Improving Mental Health? A Multi-Study Analysis*, 44 ENV'T SCI. & TECH. 3947, 3951 (2010).

136. *See* Bratman et al., *Nature and Mental Health*, *supra* note 7, at 1, 2.

137. See discussion of urban ecosystem services *supra* Section I.A; Laurence Jones et al., *Urban Natural Capital Accounts: Developing a Novel Approach to Quantify Air Pollution Removal by Vegetation*, 8 J. OF ENV'T ECON. & POL'Y 413, 414–15 (2019); *see also* D. Nutsford et al., *An Ecological Study Investigating the Association Between Access to Urban Green Space and Mental Health*, 127 PUB. HEALTH 1005, 1008 (2013) (discussing proximity effects on mental health).

138. *See* Emma Coombes et al., *The Relationship of Physical Activity and Overweight to Objectively Measured Green Space and Use*, 70 SOC. SCI. & MED. 816, 816 (2010); *see also* Cecil Konijnendijk van den Bosch, *Promoting Health and Wellbeing Through Urban Forests - Introducing the 3-30-300 Rule*, IUCN URBAN ALLIANCE (Feb. 22, 2021), https://iucnurbanalliance.org/promoting-health-and-wellbeing-through-urban-forests-introducing-the-3-30-300-rule [https://perma.cc/AXX2-YECS]; Tim G. Williams et al., *Parks and Safety: A Comparative Study of Green Space Access and Inequity in Five US Cities*, 201 LANDSCAPE & URB. PLANNING 103841, 103841, 103848 (2020) ("Proximity to parks is a necessary requirement for access, even if it is not the only dimension of access." Other dimensions include availability, acceptability, affordability, adequacy, and awareness.).

139. *See* Bikomeye et al, *supra* note 11, at 8435 ("If people cannot safely get to the greenspace, or they do not know where the green space is, or they can only arrive by car, they will not use it.").

140. *See id.*; *see also generally* Williams et al., *supra* note 138.

3. Temporal Effects: Frequency Over Time

Frequency relates to how often a patient is exposed to the NT/NBS over time. Generally, regular exposure over long periods of time optimizes health outcomes.[141] AR1 stated that repetitive exposures (particularly as a regular weekly routine), with an approximate aggregate minimum total of 120-150 minutes/week, creates a sustained benefit.[142] Due to the dearth of longitudinal studies on NT/NBS, exact frequency of exposure (e.g., weeks, months, or years) for lasting health effects is uncertain. According to P2, the health effects of a multi-day immersive camping experience begin to dilute over the course of months if participants do not maintain the benefits through frequent local nature experiences. It is possible that health benefits of any individual dose experience will eventually deteriorate with time regardless of its quality or intensity, which is one reason why long-term protection of Health Forests may be so important for population health over time.

4. Subjective Experience & Importance of Health Programming

Research interviews revealed the extreme importance of the individual's subjective experience of safety, sense of place, and, in some cases, feelings of empowerment, while engaging with the NT/NBS. [143] That is, that extent to which the NT/NBS delivers a health effect depends, in part, on the patient's enjoyment of (or past trauma with) certain natural features in the space (i.e., what kind of Nature does the patient most enjoy and feel comfortable in; how does the patient interpret the natural world in the space?). These experiences can be very culturally dependent as well as trauma-affected. [144]

Because the setting and program must engender a feeling of safety before the space can have a healing effect,[145] NT/NBS are likely to be more

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141. Unfortunately, I could find no peer-reviewed, published research that clearly establishes how long the beneficial effects of an exposure to NT/NBS can last or how long one must engage in nature-based health practices to have lasting beneficial outcomes. My interviews suggested that beneficial exposures must be repetitive for sustained health benefit. *See* Toker Thesis, *supra* note 19, at 32. This is a question ripe for further research.

142. *See id.* (personal conversation with AR1); *infra* App'x A.

143. *See* Toker Thesis, *supra* note 19, at 32 n.11 (personal communications with AR1, AR2, and P2); *infra* App'x A; Naomi A. Reichs et al., *The Power of Sacred Places*, NATURESACRED, at 11 (Nov. 2021), https://naturesacred.org/wp-content/uploads/2021/11/Power-of-Sacred-Places_digital.pdf [https://perma.cc/FZP8-C6DT].

144. *See* Hartig et. al, *supra* note 12, at 219–20; CAROLYN FINNEY, BLACK FACES, WHITE SPACES: REIMAGINING THE RELATIONSHIP OF AFRICAN AMERICANS TO THE GREAT OUTDOORS 54 (1st ed. 2014).

145. *See* Toker Thesis, *supra* note 19, at 33 (personal communications with AR1, P1, P2, AR2, P4); *infra* App'x A.

beneficial (and used) if there are programmed sessions, led by trained HPPs, than if a patient is asked to go alone to an Urban Greenspace for self-treatment. Some people will independently treat themselves by visiting Urban Greenspaces on their own, if they can. But often, treatments are more successful when (i) the human-nature connection is moderated (e.g., when people are shown how to interact with Nature for maximum health benefit), (ii) when people are together in group sizes appropriate for the treatment of their diseases, and (iii) when people are assured of their safety by someone familiar with the space's nature and safety features and/or when they can be accompanied by peers or family members.[146] For these reasons, NT/NBS Health Programming is extremely important.

Both programming and spatial design should consider factors that affect *each individual's experience of personal safety, physical limitations, and understanding of natural features.*[147] These considerations will affect how many people should be present in any NT/NBS Health Programming session, whether it should be guided, the density of vegetation and extent of immersion in Nature, and the cultural cues of the space.[148] For example, because one potential pathway for health effects is through increased social cohesion, AR2 believes that NT/NBS Health Programming is best undertaken in group sizes of approximately 5-12 people.[149] P2 believes that optimal group sizes occur in the 20-25 person range within NT/NBS Health Programming (assuming participants can separate and engage in individual activities, but come back together for group events or meal times).[150] Exact group sizes will vary with size of NT/NBS, target illnesses, and design characteristics of the NT/NBS. Both design and programming of the space can, and should, address these sensitivities in ways consistent with the drivers and indicators of ecosystem health.

Because the total number of people in the NT/NBS must be controlled to ensure health benefits, there should be a maximum number of people allowed

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146. *See* Toker Thesis, *supra* note 19, at 33 (research interviews with P2, AR2); *infra* App'x A.

147. For people recovering from stroke or in need of active physical rehabilitation, certain design features of the natural area are particularly important. According to P4, the following features are necessary for a patient's experience of safety: 1. Features modified to improve accessibility; 2. Well-defined parameters; 3. Benign and supportive conditions; 4. Universal design — designed for people with the widest range of conditions; 5. Recognizable Placemaking — simple, unified, and easily comprehended places. These circumstances and features likely require a more designed experience in the context of a hospital or rehabilitation center than NT/NBS can provide. *See id* at 32–33; *infra* App'x A.

148. *See* Toker Thesis, *supra* note 19, at 31–32 (personal communications with AR2 and P2); *infra* App'x A.

149. *See* Toker Thesis, *supra* note 19, at 33.

150. *See id.*

in the space (at least during NT/NBS Health Programming).[151] The maximum number should be set after considering type of NT/NBS Health Programming to be offered, the size of the NT/NBS and its ability to meet dosage requirements as the number of people increases, and the expected subjective experiences of personal safety (discussed above), all of which may substantially limit the maximum number of people in the space at any given time. Therefore, any NT/NBS that optimizes health and ecological performance will have to be a place in which owners and operators are able to control and manage total occupancy in the NT/NBS and participation in NT/NBS Health Programming.

C. Integrating and Applying the Data: "Health Forest" Networks

With the right kinds of NT/NBS designs, strategies, and guiding principles, we can create urban NT/NBS that can then be widely deployed in key locations; they can be assembled into networks and designed to provide ecosystem restoration services *and* a range of flexible NT/NBS Health Programming that can be refined and improved as research provides further insight into ways to optimize health and ecological outcomes. Using my findings, I developed a set of parameters and essential features for NT/NBS that can maximize health and environmental benefits in urban areas of piedmont ecoregions[152] in the most cost-effective way. Health Forests must have the following characteristics and features: (i) they should be native to the local ecosystem and mirror as closely as possible the native, pre-development forest habitat of the area; (ii) they should be located within and across urban neighborhoods and be of sufficient size; (iii) they should be designed, controlled, operated, and managed for ecological and health benefits as equally important priorities (i.e. neither should be sacrificed for the other), while ensuring participant safety at all times; and (iv) health experiences should be managed with NT/NBS Health Programming. Each of these features is discussed in detail below.

1. Start with Native Forests

For the target geographies of this Article, the optimal natural context for NT/NBS is native forest patches. Native forests[153] are the kind of Nature

151. *See id.*

152. See *supra* note 20 and accompanying text (discussing the ecoregion focus of this Article).

153. The term "forests" can mean many different things to different people in different professions and with different agendas. *See generally* Robin L. Chazdon et al., *When is a Forest a Forest? Forest Concepts and Definitions in the Era of Forest and Landscape Restoration*, 45 AMBIO 538, 538 (2016), https://doi.org/10.1007/s13280-016-0772-y [https://perma.cc/M484-6WM9]. Here, the term is used with the objective of conserving and

that can optimally meet key health and environmental restoration goals. There are many reasons why native habitat, and native forests, in particular, are so well suited to NT/NBS: (i) forests offer most (or all) of the characteristics that optimize nature dose *for a broad range of individual participants*[154], and (ii) they can be easily (and cheaply) grown and managed to maximize ecosystem health. Healthy forest patches support and promote biodiversity on a range of measures, including interaction and structural diversity, and the regular cycling of matter and energy, and they regenerate naturally.[155] More urbanized, manicured, and manufactured green spaces (e.g., street trees, rose gardens, or turf grass lawns), while they are helpful components of urban greening, are suboptimal as high-efficacy NT/NBS because they do not optimize dose or ecological health as well as forests can.[156] Forests may also maximize certain chemical nature-body interactions (i.e., exposure to phytoncides).[157] They offer sensory immersion in nature, and they can be designed for safe and experiential learning. Forests have been extensively studied for health benefits for over 30 years, with numerous demonstrated health benefits for people.[158] Finally, forests (whether young or old) appear to accommodate the range of most people's enjoyment and/or tolerance of Nature.[159] For some people, urban forests may be on the outer edge of their comfort level with Nature; however, these discomforts can be

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restoring natural ecosystems and ecosystem health. *See id.* As such, forest here would mean a forest (or forest fragment) that mirrors the structure, density, and vegetation types of predevelopment habitat, seeking to maximize ecosystem functions and species interactions — albeit with such variations as are absolutely necessary to account for climate change and NT/NBS Health Programming. *See id.* The United Nations defines a forest ecosystem as "a dynamic complex of plant, animal, and micro-organism communities and their abiotic environment interacting as a functional unit, where trees are a key component of the system." *Forest Ecosystem*, INFORMEA, https://www.informea.org/en/terms/forest-ecosystem [https://perma.cc/2FG5-0KND] (last visited Aug. 26, 2023).

154. As noted in the section on subjective experience, for individuals in active recuperation or rehabilitation after physical trauma, a rehabilitation or hospital healing garden is likely the optimal nature context. Teresia Hazen, *Therapeutic Garden Characteristics*, 41 AM. HORTICULTURAL THERAPY ASS'N 1, 3 (2015).

155. *See* Toker Thesis, *supra* note 19, at 34.

156. *See id.* As noted above, the closer the NT/NBS replicate or regenerate pre-development habitat (with possible adjustments to account for projected climate change), the more likely we are to support ecological health of the surrounding ecosystem and the fewer inputs we should need for successful growth. K. Wolf et al. also note that human health benefits depend in part on whether the forest (or NT/NBS) itself is healthy, which is most likely for vegetation native to the area (unless it becomes colonized by competing, invasive plants). *See* Wolf et. al, *supra* note 13, at 4388 ("The [health] benefits of trees are affected by the health status of trees and forests.").

157. Li, *supra* note 81, at 12–13.

158. *See* Wolf et al., *supra* note 13, at 4372.

159. *See generally* Hansen et al., *supra* note 81; Toker Thesis, *supra* note 19, at 34 (personal communication with P2); *infra* App'x A; Wolf et al., *supra* note 13, at 4372.

managed with nearby open areas, facilities/structure that provide shelter, and NT/BS Health Programming. For other people, urban forests may not offer the dosage intensity they desire in the way a wilderness experience might, but this problem can be managed in various ways, such as by increasing vegetation density in the NT/NBS and designing secluded areas that are more isolated from groups of people.

From both a financial and social equity perspective, it is best if the NT/NBS maximizes positive health outcomes for the broadest range of people with costly diseases, while simultaneously maximizing ecosystem services and ecosystem health for the local area (including for those who may not suffer specific chronic diseases or have direct access to the NT/NBS). Forests do this. Native forests[160] will also be the easiest and cheapest type of ecosystem to regenerate while having the greatest beneficial impact on the local ecosystem. [161] And small forests can and do exist within cities and close to target populations.[162]

2. Optimize Location and Size

Optimal Location

Urban forests, when located in residential neighborhoods or near office/mixed-use locations, can provide the access, proximity, and frequency that optimize health outcomes. In fact, the need for proximity, easy access, and frequent exposure suggests that locating NT/NBS close to where people live or work is extremely important for effective nature-based health

160. While native forest patches may be optimal, other native habitat types for a given local micro-climate may be more appropriate while still offering required characteristics in the space. Using native habitat other than forests should be considered on a case-by-case basis.

161. I note here that with a focus on eastern piedmont regions — especially urban areas within the Chesapeake Bay watershed — there has historically been low risk of unmanaged forest wildfires due to traditional patterns of rain and moisture levels. If forest fires become a more common hazard in this region, the costs of fire prevention and management would affect the financial analysis below. *See, e.g.*, Norm Christenson & Jerry Franklin, *New Trees are no Substitute for Old Trees*, POLITICO (June 11, 2023, 7:00 AM), https://www.politico.com/news/magazine/2023/06/11/to-fight-wildfire-our-forests-need-to-grow-old-00101360 [https://perma.cc/3MXD-BZFP].

162. *See e.g.*, *About*, CITIES4FORESTS, https://cities4forests.com/about/ [https://perma.cc/KQ5N-534H] (last visited July 30, 2023); BIOPHILIC CITIES, https://www.biophiliccities.org/ [https://perma.cc/AH24-FXEJ] (last visited July 30, 2023); BALT. GREENSPACE, https://baltimoregreenspace.org/ [https://perma.cc/296F-9TZV] (last visited July 30, 2023); *Silviculture in the City: Urban and Climate Adapted Management Strategies for Forested Natural Areas in the Northeastern U.S.*, FOREST SERV., https://www.fs.usda.gov/research/nrs/news/featured/silviculture-city-urban-and-climate-adapted-management-strategies-forested [https://perma.cc/2AJQ-LMYV] (last visited July 30, 2023).

practices with long-term outcomes.[163] To meet the frequency, proximity, and temporal requirements, Health Forests should be walkable from where targeted individuals (for these purposes, targeted insureds[164]) live or spend the bulk of their time, and ideally should be visible from their location.[165] The importance of proximity and frequency of exposure to Nature over extended periods of time is so crucial to the therapeutic aspects of Nature, that the Nature Based Solutions Institute has proposed a "3-30-300 rule," a guideline that emphasizes the importance of equity and access in urban forestry so that all residents benefit from urban trees and forests.[166] The 3-30-300 rule provides that individuals should be able to see at least three trees from their home, that there should be a 30% tree canopy cover in each neighborhood, and the maximum distance to the nearest high-quality public green space should be 300 meters (.186 miles).[167] This approach also maximizes ecological impact in urban space by increasing, distributing, and connecting areas with Nature across the urban fabric.

Optimal Size

Given the dose parameters and viable opportunities, urban forest patches in the size range of one-half to one acre appear to be optimal. Properties within this size range can strike the ideal balance among (i) maximizing health outcomes, (ii) maximizing ecosystem restoration/resilience outcomes, and (iii) accommodating common urban spatial and cost constraints. Finding the right size NT/NBS requires considering the size needed to meet nature

163. Proximity is particularly important for low-income and environmental justice communities since access to Nature continues to be inequitable across cities. Zellmer & Goto, *supra* note 25, at 2 ("Because access to nature remains deeply inequitable across cities . . . losses of urban wildlife will disproportionately impact low-income communities and communities of color."). Not all environmental scientists agree on the best spatial configuration for urban greenspaces or forest patches across urban metropolitan areas when seeking to support and promote biodiversity. This Article assumes that an increase of Health Forests across urban areas — particularly those with extensive impervious surfaces — can only benefit biodiversity by adding forest patches where none exist today. However, questions related to this issue are beyond the scope of this Article.

164. An "insured" is a person insured by a given private healthcare payer. Note that "insured," "subscriber," and "insured/subscriber" are used interchangeably in this Article. As discussed below, to monetize the health benefits of Health Forests, healthcare payers will need to target their insureds/subscribers for treatment. *See infra* Sections III.A–B.

165. *See supra* notes 137–40 and accompanying text; Konijnendijk van den Bosch, *supra* note 138.As discussed below, to monetize the health benefits of Health Forests, healthcare payers will need to target their insureds/subscribers for treatment.

166. Konijnendijk van den Bosch, *supra* note 138.

167. *UNECE Supports Sustainable Urban and Peri-Urban Forestry for Public Health, Climate Resilience and Green Recovery*, U.N. ECON. COMM'N FOR EUR. (Feb. 22, 2022), https://unece.org/climate-change/press/unece-supports-sustainable-urban-and-peri-urban-forestry-public-health-climate [https://perma.cc/Y2NC-JEJH].

"dosage" requirements, the physical limitations of participants, the target illness(es) to be treated, the NT/NBS Health Programming approaches and goals, the anticipated subjective experiences[168] (e.g., planned treatment group sizes and prior experiences with Nature; ensuring the feel of being "in" nature without feeling crowded), the intensity of ecological function needed in the surrounding neighborhood and the land uses surrounding the NT/NBS,[169] and the land area necessary to house abundant, biodiverse, and healthy Nature in the space. From a cost perspective, parcel sizes need to balance the costs of acquisition and operations (and what can be feasibly acquired within urban environments) with projected revenues from treating large numbers of insureds, without overcrowding the space. Crowding can become a concern due to subjective experiences that inhibit health benefits and due to potential damage to the ecology of the space from crowding too many people in at once. Unfortunately, no academic studies of optimal NT/NBS occupancy were published during the research period.[170] However, Guo et al. studied occupancy and crowding as a function of the land area of certain viewing spots in high-traffic parks in China; this research considered ideal sized groups, acceptable sized groups, and crowded groups with respect to subjective enjoyment of the visit, safety for the visitors, and damage to the site.[171] That research suggests that optimal person to size ratio is often less than half of the maximum number that can be safely accommodated in a space.[172]

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168. *See supra* Section II.B.4; Toker Thesis, *supra* note 19, at 40.

169. *See* Toker Thesis, *supra* note 19, at 35 (personal communications with AR1, P1, P2, P3, AR2, P4); *infra* App'x A.

170. A group researched overcrowding at certain high-profile, high-traffic UNESCO World Heritage Sites and the threshold at which crowding becomes unpleasant or dangerous for people and found an outer limit of *no more than* one person per square meter for viewing areas would be preferable. Preferred crowd management would call for less than half that. *See* Jin-Hui Guo et al., *Managing Congestion at Visitor Hotspots Using Park-Level Use Level Data: Case Study of a Chinese World Heritage Site*, 14 PLOS ONE 1, 7 (2019); *see also* Zhi Yue et al., *Visitor Capacity Considering Social Distancing in Urban Parks with Agent-Based Modeling*, 18 INT'L J. OF ENVT'L RSCH. & PUB. HEALTH 1, 2 (2021) (describing the numerous approaches to identifying maximum park carrying capacity that have developed); *see also supra* note 135 and accompanying text; *infra* note 160 & Section II.B.4.

171. *See generally* Guo et al., *supra* note 170.

172. As evidenced by the experience of certain public parks, it is well established that overcrowding in a nature space can lead to ecological damage. *See Beautiful but Crowded - Review of Great Falls Park, McLean, VA*, TRIP ADVISOR, https://www.tripadvisor.com/Attraction_Review-g60726-d285884-Reviews-or10-Great_Falls_Park-McLean_Fairfax_County_Virginia.html [https://perma.cc/H84N-6DDW]; *see also* Jeremy Wimpey & Jeffrey L. Marion, *Formal and Informal Trail Monitoring Protocols and Baseline Conditions: Great Falls Park and Potomac Gorge*, U.S. GEOLOGICAL SURVEY (2011), https://pubs.er.usgs.gov/publication/70004552 [https://perma.cc/2R63-LDFF]; Kurt Repanshek, *Reader Poll: Are Crowds in Parks a Concern?*, NAT'L PARKS TRAVELER (Feb. 2, 2022), https://www.nationalparkstraveler.org/reader-poll-are-crowds-

3. Operate for Ecological and Health Outcomes While Ensuring Safety

Outside of hospital settings, Health Program Providers often rely on public lands for their operation.[173] However, it is important, for NT/NBS to be maximally effective, for operators to be able to (i) control (and manage) the landscape design specifically for health and ecology (as opposed to aesthetics, tourism, marketing, or crowds) — particularly in terms of vegetation species and density, vertical/horizontal structure, and spatial layout; (ii) to control occupancy (in terms of how many people can be in the space at any given time, and to ensure that anyone present in the space who is not part of the programmed experience is not disturbing or interfering in a way with NT/NBS Health Programming or site ecology);[174] (iii) to ensure the space is maintained optimally for health and environmental purposes; and (iv) to provide minimal but adequate site facilities, structures, and hardscaping that ensure health and safety goals can be met but that do not interfere with goals to maximize ecological quality and ecosystem health and to increase cost efficiency.[175]

4. Incorporate NT/NBS Health Programming

As noted above, each individual's subjective experience of the NT/NBS — particularly in terms of feelings of safety — will have a large effect on the health outcome for that individual. Especially for residents of highly urbanized areas, NT/NBS Health Programming can play an essential role in helping people understand why and how the space is safe, and to allay concerns that may arise due to personal fears or cultural-ethnic-historical

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parks-concern [https://perma.cc/UDR5-U5GG] (finding that overcrowding is becoming recognized as a problem); Yue et al., *supra* note 170, at 2 (considering numerous methodologies for assessing optimal occupancy of park areas and challenges avoiding ecological damage to sites from crowds).

173. *See* PARK RX AMERICA, https://parkrxamerica.org/others/ [https://perma.cc/W33M-H5ME] (last visited July 28, 2023); *see also* Jennifer Frank, *Medical Providers Are Taking Nature Therapy Seriously*, NEXT CITY INC. (Mar. 15, 2021), https://nextcity.org/urbanist-news/medical-providers-are-taking-nature-therapy-seriously?gclid=CjwKCAjwq4imBhBQEiwA9Nx1BnRk9DeP9RpeerBQB-IDgRxoN0CFo-2wqUgGjBcX0l1KosX0mShpfRoC2cEQAvD_BwE [https://perma.cc/MA9B-A4BK].

174. *See supra* Section II.B.

175. Too often, "natural" areas designed for health benefits overemphasize engineered hardscapes and structures to the detriment of drivers and indicators of ecosystem health. This approach also increases costs. However, it is often not necessary to achieve health goals. *See* Emma Wood et al., *Not All Green Space is Created Equal: Biodiversity Predicts Psychological Restorative Benefits from Urban Green Space*, 9 FRONTIERS IN PSYCH. 1, 2,9 (2018). It is also important to note that, in the urban context, each Health Forest site may not need a full suite of facilities on site; rather, Health Forest owners may be able to build cooperative relationships with nearby landowners (e.g., neighborhood retail shops) who agree to allow Health Forest users to use their facilities as needed.

associations with forested areas (or particular features in the design of the space). While the design itself may provide for safety cues and areas of refuge, it is also essential that people be guided in health-promoting activities, including demonstrations of how to interact with Nature safely and respectfully, and that people have opportunities to lessen their individual exposures to features that may unintentionally create fear or discomfort without reducing the ecologically important features of the space.[176] NT/NBS Health Programming can also help to mediate the tradeoffs associated with group therapy — strengthening the benefits of social cohesion, community building, and safety in numbers, while minimizing the creation of unhealthy sub-groups, the impact of distracting or disrespectful individuals, and any other hazards related to bringing diverse groups of people together for rehabilitative treatments in Nature.[177]

D. Benefits of Private Ownership & Control

Without privately owned (or use-restricted) property, it is extremely difficult, if not impossible, to operate Health Forests on a steady and regular basis while maintaining the kinds of controls just described in Section II.C.[178] In existing public parks and open spaces, HPPs cannot control who enters and exits the space during NT/NBS Health Programming (or ensure such entrants use the space in a manner compatible with NT/NBS Health Programming), nor can they ensure the space is designed, organized, and managed for optimal Nature dosage to achieve optimal health outcomes. Not only are public parks suboptimal from a design and operations perspective, but they are often scarce, overburdened, and inequitably distributed.[179] As a

176. Forest therapy is one kind of nature-based health treatment, but it is not a random walk in the park. Forest therapy is a "practice of developing a deepening relationship of reciprocity, in which the forest and the [patient] . . . [to support] the wholeness and wellness of each. In Forest Therapy, there is a clearly defined sequence of guided events that provides structure to the experience, while embracing opportunities for creativity and serendipity." *See Home*, GIVING CYPRESS, https://www.thegivingcypress.com/copy-of-home [https://perma.cc/YJ4U-C7VK] (last visited Aug. 26, 2023).

177. *See id.*

178. Whether it is possible (i) for federal or state governments to operate Health Forests themselves under the stated parameters or (ii) for private entities to own and operate Health Forests using federal healthcare funding sources is outside the scope of this Article; however, future research should examine whether federal funding assistance for Health Forests, in exchange for the imposition of long-term forest protections and/or to ensure environmental justice priorities and equitable access, could produce greater benefits to all parties.

179. *See Land Equity Commitment: Trust for Public Land*, TRUST FOR PUB. LAND, https://www.tpl.org/our-mission/equity [https://perma.cc/P6D3-84ZQ] (last visited August 2, 2023) ("But access to parks isn't equal, and disparities often fall on racial and economic divides. In low-income communities, communities of color, and rural areas, parks are fewer, smaller, more crowded, and less maintained than parks in higher-income or predominantly white communities."). It is common to find fewer parks in areas with socially vulnerable

result, existing public parks are often crowded, over-utilized, and under-maintained.[180] In addition, urban parks incorporate various kinds of Urban Greenspace, but often are not forested;[181] and urban parks are rarely designed to maximize and prioritize human health and ecological outcomes in a single area. Such areas are not only suboptimal as Health Forests, but their often-degraded condition also indicates a clear need for *more* forested areas, rather than piling new uses on to already overburdened public parks. Even where public parks do offer healthy forested areas that could be used as Health Forests, they are not spatially distributed for ease of access by large numbers of at-risk or socially vulnerable people.[182]

III. CREATING INSTITUTIONS AND ENGAGING KEY STAKEHOLDERS FOR A NEW HEALTH FOREST "MICRO-ECONOMY"

Private sector participation in funding, as well as in the ownership and operation of, Health Forests is essential to achieve the scale of restoration necessary to meet this moment. Current grassroots and public sector efforts to promote Nature-Based Solutions to pressing urban problems like ecosystem degradation and widespread chronic disease have been unable to

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populations. *See* Yanfang Gao et al., *Effects of Ambient Particulate Exposure on Blood Lipid Levels in Hypertension Inpatients,* FRONTIERS IN PUB. HEALTH (2023); Sara Meerow, *A Green Infrastructure Spatial Planning Model for Evaluating Ecosystem Service Tradeoffs and Synergies Across Three Coastal Megacities,* 14 ENVT'L RSCH. LETTERS 1, 3 (2019) ("Many studies have shown that green spaces are not evenly distributed across cities, which is problematic given their many benefits." (citations omitted)); Wolf et al., *supra* note 13, at 4388 ("[S]tudies have found that there are often disparities in distribution of trees in urban areas"); Wolch et al., *supra* note 7, at 235 ("[W]ithin cities, green space is not always equitably distributed. Access is often highly stratified based on income, ethno-racial characteristics, age, gender, (dis)ability, and other axes of difference."); Williams et al., *supra* note 138, at 103848 ("A common approach to measure accessibility is based on geographic proximity to amenities. However, accessibility is multi-dimension and in addition to proximity also includes availability, acceptability, affordability, adequacy, and awareness.").

180. These problems collectively can contribute to a vicious circle in which disinvestment leads to other, sometimes undesirable, uses (or non-use) and such behavior then leads to further disinvestment. *See* Tyler Sammis, Playspace Greening in Low-Income Communities: Observations from U.S. Urban Park and Playfield Renovations, at 2 (May 2020) (M.A. project, Duke University) ("Long-term neglect of parks and playspaces deters productive recreation, often attracting uncivil and criminal behavior in its place."); Wolch et al., *supra* note 7, at 235 (discussing stratification of access based on ethno-racial characteristics); Williams et al., *supra* note 138 (discussing multi-dimensional nature of accessibility).

181. *See generally* Lorien Nesbitt, et al., *Who Has Access to Urban Vegetation? A Spatial Analysis of Distributional Green Equity in 10 US Cities*, 181 LANDSCAPE AND URB. PLAN. 51 (2019) (distinguishing between urban woody vegetation and urban parks in order to examine correlations among income, education, race, and vegetation types).

182. *See* Shivani Shukla, *Racial Disparities in Access to Public Green Space*, CHI. POL'Y REV. (July 20, 2023, 10:08 PM) https://chicagopolicyreview.org/2020/09/23/racial-disparity-in-access-to-public-green-space/ [https://perma.cc/VPN5-DNHG]; *see also* Land Equity Commitment: Trust for Public Land, *supra* note 179.

achieve a scale large enough to reverse current trajectories.[183] One major reason is that the public and non-profit sectors cannot accomplish coordinated regional-scale ecosystem restoration (that includes urban areas) on their own:[184] urban land and associated transaction costs are too high and small urban parcel sizes necessitate private landowner involvement.[185] This is why we not only need public sector support for traditional types of conservation on private lands, but why *we also need new private actors and investors to restore Nature on private urban lands, new markets that make such investments financially sustainable, and public sector support for those markets*.[186]

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183. Although advocacy efforts for more public parks and conservation developments in and around growing cities are expanding, *see About*, PARKRX, (July 21, 2023) https://www.parkrx.org/about [https://perma.cc/S8LV-MWEJ]; TRUST FOR PUB. LAND, https://www.tpl.org [https://perma.cc/XF87-NM27] (last visited July 21, 2023), as are local government initiatives to increase natural landscapes through conservation landscaping and reforestation incentives for private landowners, *see Conservation Landscaping*, UNIV. OF MD., https://extension.umd.edu/sites/extension.umd.edu/files/2021-03/CL_0370.pdf [https://perma.cc/XYN8-PBY3] (last visited Aug. 30, 2023), these efforts have been difficult to scale up for maximum benefit for a number of reasons, a key reason being lack of funding. *See* WHITE HOUSE REP., *supra* note 15, at 16 (describing problems of insufficient and uncoordinated funding for Nature-Based Solutions); *see also* Salma Ali et al., *Green Infrastructure: Could Public Land Unlock Private Investment?*, MCKINSEY& CO. (July 22, 2023), https://www.mckinsey.com/industries/public-sector/our-insights/green-infrastructure-could-public-land-unlock-private-investment [https://perma.cc/KZD5-CNBZ] ("To understand how wide the green infrastructure funding gap is, consider that across G-20 nations, private-sector-led infrastructure investments have remained below $160 billion in primary markets for each of the seven years leading up to the start of the COVID-19 pandemic in 2020. That's equivalent to 0.2 percent of GDP, but studies show that 5.0 percent is needed.").

184. There is intense competition for land from residential and commercial housing development, agriculture, infrastructure, and from public service needs like police, fire, recreation, schools, and public buildings, all of which make parks difficult to expand and create, particularly with limited public funds. *See generally* Zellmer & Goto, *supra* note 25 (discussing the challenge of creating connections and healthy species interactions across isolated habitat patches in urban areas).

185. See *id*. at 12 ("[T]hese smaller [urban] land parcels are . . . more difficult and expensive to fund . . . the acquisition cost per acre is higher in urban areas than more rural areas . . . and acquisition, restoration, and management of multiple land parcels is more expensive and time consuming than a single large land parcel."); *see also Birth of Conservation*, U.S. FOREST SERV. (Oct. 17, 2006), https://www.fs.usda.gov/speeches/forest-management-experience-united-states [https://perma.cc/X5FY-CT88] (explaining that most forests (approximately 58%) in the United States are privately owned. Most large areas of forest in the eastern United States are owned by private landowners. Although in the western United States, federal and state governments manage 69% of the forestland, in the East, it is only 17%.).

186. *See* LEE-ASHLEY ET AL., *supra* note 5, at 11 (calling for public support for private conservation efforts in point 4); Allred, et al., *supra* note 26, at 1 ("Globally, land-use change has been the primary driver of the decline in terrestrial and freshwater ecosystems since 1970 . . . . Whereas some areas of importance for biodiversity are protected as parks and preserves, most exist on private lands on different parcels in different jurisdictions, where

In light of the theoretical ability of highly motivated private sector entities to rapidly acquire, design, install, operate, and maintain Health Forest networks at scale in key locations, I compiled rough estimates of key cost assumptions (through interviews, case studies, and publicly-available information) to show how private entities could achieve potential returns on investment from privately owned and operated Health Forest investments (assuming acquisition, ownership, and operation of a distributed set of neighborhood-scale Health Forests).

A. Stakeholders Who Can Monetize the Benefits

Because the primary financial benefit of Health Forests will take the form of large healthcare cost reductions, it is essential to identify the private corporate entities who pay the most for chronic disease treatments and who will gain the most (financially) from highly effective, low-cost, population-scale treatment alternatives. These entities are: (i) self-insured employers[187]; (ii) "closed-system" integrated managed care organizations, like Kaiser Permanente[188]; and (iii) some private healthcare insurance companies.[189] Corporate healthcare payers (whether self-insured employers, insurance companies, or others) have to be concerned about population level expenditures as well as patient-specific expenditures, and the ability to address high-cost diseases with population-scale treatments can yield high returns. Self-insured employers have the most to gain from Health Forests (and NT/NBS more generally) because, even to the extent that covered healthcare costs are not avoided, the benefits of improved employee health

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uncoordinated, local planning decisions determine their fate." (internal citations omitted)). Society can expand available funding sources for urban Nature by allowing the private sector to monetize some of Nature's benefits — as proposed here, in the form of avoided healthcare expenditures — while adding new land and a new element to the emerging "green economy."

187. *See* Toker Thesis, *supra* note 19, at 36 (personal communication with HC2); *infra* App'x B.

188. Kate Gamble, *Kaiser's Care Model*, HEALTHCARE INNOVATION (Apr. 10, 2013), https://www.hcinnovationgroup.com/clinical-it/clinical-documentation/article/13012336/kaisers-care-model.

189. Health insurance companies may have lesser incentives than self-insured employers or closed-system health management organizations, especially if they require high deductibles or provide for large coverage exclusions; however, they can still benefit substantially from low-cost alternatives and substantial cost avoidance. Hospitals are different: hospital care accounts for approximately 1/3 of healthcare spending, and hospitals only have incentives to minimize non-reimbursable (or uncollectible) costs of care for patients admitted into their care (or penalties that may accrue under federal healthcare policies. *See Hospital Rate Setting: Successful in Maryland, but Challenging to Replicate*, ALTARUM HEALTHCARE VALUE HUB (May 2020), https://www.healthcarevaluehub.org/advocate-resources/publications/hospital-rate-setting-promising-challenging-replicate [https://perma.cc/7SZ8-5MTV]; *see also* Toker Thesis, *supra* note 19, at 36 (personal communication with HC2); *infra* App'x B.

and well-being still accrue to the employers in increased productivity, employee engagement, and reduced employee turnover.[190]

B. Financial Feasibility and Key Cost Considerations

The financial costs and benefits of implementing Health Forest networks are necessarily speculative at this time (since none have yet been implemented and systematically studied for potential returns on investment); however, I gathered data to establish a plausible range of cost and revenue assumptions — as they would pertain to a healthcare payer willing to fund a Health Forest (i.e., the "Investor"). I used data primarily from Washington, D.C. and Baltimore, Maryland for land values and installation cost estimations. My findings suggest that, if Health Forests can reduce even 20% of the Investor's annual average covered healthcare expenditures for groups of targeted patients with cardiovascular diseases (CVD) (or equivalent covered costs), healthcare payers could reap substantial financial benefits from funding the creation and operation of Health Forests over a six to ten-year time horizon. Using the cost estimates described below, a simple pro forma financial calculation that examines acquisition and construction costs, operating and maintenance costs, and healthcare cost savings attributable to Health Forests shows potential internal rate of return (IRR) in excess of 30% on the necessary investment. These are conservative estimates, since the research suggests that Health Forests would reduce numerous expenditures attributable to many highly prevalent, chronic diseases.[191] The financial effects of replacing certain conventional chronic disease treatments (and their associated expenditures) with Health Forests and NT/NBS Health Programming can be massive if sufficient at-risk or affected insureds/subscribers can be recruited to participate.

1. Primary Components of Financial Analysis

At the site level, the key drivers of whether Health Forests are financially feasible are (i) the cost of the initial investment to acquire and create the

190. *See* Toker Thesis, *supra* note 19, at 36 (personal communication with HC2); *infra* App'x B; BILL BROWNING ET AL., THE ECONOMICS OF BIOPHILIA 3 (2015), https://www.terrapinbrightgreen.com/report/economics-of-biophilia/ [https://perma.cc/AH8R-CC4Q].

191. The financial estimates reviewed in this Section III.B are presented in a sample pro forma spreadsheet attached to the Toker Thesis, *supra* note 19. The full excel workbook with financial sensitivity analysis is on file with the Author. Estimates of financial returns, in particular, are conservative because they assume the projects are funded fully with equity/investment capital from healthcare payers; if low-cost debt or public subsidies were included, returns could be higher. In fact, partnerships with public health care entities (like federal or state healthcare payers) or government natural resources departments could incorporate public funding that would boost returns much higher.

Health Forest, (ii) the cost of operations and maintenance for optimal health and ecological outcomes, (iii) the cost of running NT/NBS Health Programming, (iv) the discount rate/cost of capital, and (v) the total dollar value of the Investor's avoided healthcare expenditures attributable to the use of Health Forests in lieu of conventional treatments. The following sections describe these measures of costs and revenues more specifically.

Estimated Costs

Cost estimates included initial capital investment costs, operating and maintenance costs, and the costs of NT/NBS Health Programming. [192] Initial investment was estimated at $610,000 for a half-acre parcel, and annual expenses estimated at $316,000 (~$262,000 for HPPs and $54,000 for operations and maintenance), escalating at 3% annually. Details and supporting assumptions for these numbers are:

1. *Initial Capital Investment Costs*.[193] This category includes costs of: (i) land acquisition[194] (assuming raw land or land with small structures); (ii) predevelopment and "build out": forest regeneration, design and entitlements, and installation of health program features and required

192. NT/NBS cost assumptions were based primarily on personal communications, including interviews, but were also informed by all data collected. *See* Toker Thesis, *supra* note 19.

193. The cost estimates used assume that all initial capital expenditures (outside of routine maintenance) are invested in Year 0, and that acquisition and regeneration can occur sufficiently within the first year to begin granting insured access to NT/NBS and NT/NBS Health Programming after one year. Some may argue that commencing operations in Year 1 is unrealistic because newly planted native trees can take in the range of 20-30 years to reach maturity. I offer the following for consideration: (i) health benefits do not only accrue in mature forests with closed canopy (although closed canopy can contribute to the experience of sensory immersion) — size and design of the space will also affect this experience; (ii) health benefits can occur in early successional stages of forest growth; (iii) the age of trees planted at installation will affect the size of trees at planting, and although more mature trees are more costly to purchase and plant, they may help accelerate health benefits for certain Health Forests, and (iv) some Health Forests may be partially planted when acquired or be adjacent to other forested areas, either of which may assist in providing health benefits as the regenerated forests mature. *See generally* Toker Thesis, *supra* note 19. It is important to commence health operations as soon as possible after installation to ensure adequate monetary returns and get maximum exposure to the largest number of people. Some people are turning to the Miyawaki Method and creating "tiny forests" in urban areas. These small-footprint forests use densely planted young indigenous species and are designed to grow to meaningful size within 1 year. *See* Elizabeth Hewitt, *Why "Tiny Forests" Are Popping Up in Big Cities*, NAT'L GEOGRAPHIC (June 22, 2021), https://www.nationalgeographic.com/environment/article/why-tiny-forests-are-popping-up-in-big-cities?loggedin=true&rnd=1687986219550 [https://perma.cc/QX52-HJXN] ("The forests can be built in under a year.").

194. An alternative to full capital investment in the first year is to have landowners ground lease the land rather than acquire by fee title — this could spread initial acquisition costs out over time — as discussed further below. *See infra* Section IV.C.

facilities (i.e., restrooms, weather shelter, and/or surface parking, if necessary);[195] (iii) possible demolition or repurposing of existing structures (including pavement/hardscape removal). At the time my research was conducted, land sales prices in Washington, D.C. ranged from $29/sf to $100/sf in lower cost neighborhoods. Land sales prices in Baltimore ranged from $5/sf to $144/sf around the central city. For a half-acre parcel of land, cost modeling used approximately $500,000 land acquisition price (or $23/sf) and total initial investment of $610,000 (or $28/sf). Despite that relatively low-cost assumption, additional modeling and sensitivity analysis suggested that avoidance of at least 20% of estimated healthcare costs (CVD only) could justify an initial investment of up to nearly $80/sf (using 2021-dollar cost estimates).[196]

2. *Operating and Maintenance Costs* (beginning in first year of operations). This includes costs of: (i) maintenance for healthy forest growth, features used for NT/NBS Health Programming, and stewardship of structures and signage;[197] (ii) all utility, insurance, and property taxes. Operating and maintenance expenses were estimated at approximately $54,000/year (in 2021 dollars) and were assumed to escalate at 3% per year.[198]

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195. Additional initial investment costs include: (i) $2.35/square foot for tree planting, forest regeneration, and installation; (ii) 3.42/square foot for design and installation. *See* Toker Thesis, *supra* note 19, at 60 (personal communications with members of the Maryland Executive Directors of Land Trusts listserv, October 29, 2021– November 1, 2021). This cost will depend heavily on level of ecological degradation of land site, the extent to which the space will be managed for special needs, and the security needs given the location. *See id.* (based on Author's professional experience with projects through Urban Ecosystem Restorations, an urban land trust in Maryland, and personal communications with Jack Sullivan, designer of the Green Road at Walter Reed Naval Hospital, dated October 28, 2021–November 1, 2021, and P4); *infra* App'x A.

196. Land acquisition: $23/square foot is assumed in the model for vacant land in Washington, D.C.-Baltimore-Virginia region. *See* Toker Thesis, *supra* note 19, at 37, 60. This assumption is likely too low for the Washington, D.C. area, but high for the Baltimore area. Sensitivity analysis for cost of initial investment was a key factor in determining feasibility. The cost of the initial investment can increase to well over $1,000,000 for the half-acre parcel (and up to ~$75/sf) so long as net cost savings remain near 20%. *See id.*

197. Costs of operating NT/NBS Health Programming in the space were broken down separately from the above operating and maintenance costs (even though they are also operating costs) so that they could be directly subtracted from the costs of conventional therapies. Costs of property security systems were not included due to wide range of potential technologies and costs; however, cost variability that could account for such costs were incorporated into a sensitivity analysis that informed the feasible cost estimate ranges. *See id.* at 22.

198. Because annual operating and maintenance costs are highly variable and property specific, sensitivity analysis was performed on these costs. Insurance: $0.22/sf, based on author's professional experience with projects through Urban Ecosystem Restorations. Taxes: $0.22/sf, based on author's professional experience with projects through Urban Ecosystem Restorations. Maintenance and property management: $1/sf. This number will be highly

3. *Cost of NT/NBS Health Programming*. To optimize outcomes, the Health Program Providers who deliver NT/NBS Health Programming should be trained in a form of nature-based health practice tailored to the target patient population. HPPs will ideally be certified by recognized national or international associations wherever possible.[199] Given the nascent state of the HPP market, there is not a well-established rate of payment for trained HPPs, so the cost estimates used the horticultural therapy rates in place at Legacy Rehabilitation Institute of Oregon (RIO) and assumed a rate equal to $35/hour for one therapist per five patients.[200] Since the financial estimates assume groups of 20 people attend each one-hour treatment session, the estimates assume an hourly cost for HPPs of $140/hour (i.e., $35 x four groups of five people each treatment session). The annual cost for NT/NBS Health Programming is estimated at $262,000, escalating at 3% annually.[201]

Estimated Annual Revenues

Annual gross revenues to a healthcare payer from Health Forest operations were estimated to be approximately $437,000 per half-acre Health Forest (assuming a healthcare payer could save only 20% of its average CVD cost per insured), and *net revenues* (i.e., avoided healthcare costs *net* of Health Forest expenditures) for the same Health Forest were estimated to be approximately $125,000.[202] The gross revenue calculation took 20% of a hypothetical healthcare payer's average cost per insured for CVD (the

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variable and assumes some help from volunteer labor. Cost assumption sources from personal communications with members of the Maryland Executive Directors of Land Trusts listserv, October 29, 2021 – November 1, 2021. *See id.* at 60.

199. *See, e.g.*, ASS'N OF NATURE & FOREST THERAPY GUIDES & PROGRAMS, *supra* note 18; INT'L SOC'Y OF NATURE AND FOREST MED., https://www.infom.org [https://perma.cc/5A9J-XM9M] (last visited July 23, 2023); INT'L NATURE AND FOREST THERAPY ALL., https://infta.net [https://perma.cc/H7G6-Q5GH] (last visited July 23, 2023).

200. This hourly rate is based on personal communications with P4, with operations primarily in the Pacific Northwest. This rate would likely need to be higher for metropolitan areas of the East Coast. *See* Toker Thesis, *supra* note 19, at 59; *infra* App'x A.

201. The financial analysis assumes that a one-half acre Health Forest can accommodate 36 one-hour treatment sessions per week. *See* Toker Thesis, *supra* note 19, at 22; *infra* note 207. The model also assumes that the healthcare payer covers the full cost of NT/NBS Health Programming; however, Health Forest owners and HPPs could require co-payments from insureds or charge fees for services for patients out of network to pay part of the cost of programming and treatment.

202. Revenues from avoided costs. "If conventional avoided healthcare costs (i) are substantially reduced for some other reason, or (ii) Health Forests are not able to offset at least 20% of annual covered expenditures, the financial value of the Health Forests is reduced. However, these financial estimates assume that healthcare payers fund the entire acquisition, operation and maintenance, and health programming budget, which does not necessarily have to be the case. Healthcare payer returns could be substantial even in a low net cost avoidance scenario if another entity funds part of these establishment or operating costs." Toker Thesis, *supra* note 19, at 38.

"savings" or "revenues") and multiplied that number times the number of insureds to be treated in the Health Forest. The net revenue calculation, as further described below, took gross revenues, and subtracted the costs of operation, maintenance and NT/NBS Health Programming (using calculations described above). Under this 20% offset scenario, the net present value calculation for a 6-year investment equals $1.13 million. Key variables and assumptions for revenues are:

1. *Average Healthcare Payer Costs Per "Treated" Insured.* To calculate cost avoidance (or revenue) for a healthcare payer, I used the average healthcare cost for individuals with (or at high risk for) CVD as published by the Medical Expenditure Panel Survey (MEPS):[203] this figure was $5,691 per person in 2019. Because a healthcare payer would not normally cover 100% of these costs, I used 80% (a common insurance coverage percentage) to represent the portion of the healthcare costs a healthcare payer would probably pay.[204] Then, I took 20% of that number to model a hypothetical scenario in which the use of Health Forests could

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203. For cost data on CVD, see *Information on the Health Status of Americans, Health Insurance Coverage, and Access, Use, and Cost of Health Services*, AGENCY FOR HEALTHCARE RSCH. & QUALITY, DEP'T OF HEALTH & HUM. SERVS., https://datatools.ahrq.gov/meps-hc#varexpLabel [https://perma.cc/7PNU-EQCT] (last visited Aug. 1, 2023) (click on Annual/Main Public Use Files then Go). For an explanation of why only CVD costs were used in financial estimates and feasibility analysis, as opposed to the costs of a broader range of chronic diseases, see Toker Thesis, *supra* note 19, at 23.

204. The percentage of healthcare costs covered (or paid by) private healthcare payers, like insurance companies, is often not provided in literature and large government data studies for the annual or national costs of diseases. Some data provides the portion of population-level healthcare costs generally borne by third-party payers, but that data normally does not reflect the cost percentage that any particular insurance policy would cover for its own insured members. Available evidence shows that the percentage coverage would likely be around 80% (more with extensive coverage and less with high deductible or lower coverage insurance plans); for self-insured employers, the percent coverage is often higher. Sam Hughes et al., *Health Ins. Costs are Squeezing Workers and Employers*, CTR. FOR AM. PROGRESS (Nov. 29, 2022), https://www.americanprogress.org/article/health-insurance-costs-are-squeezing-workers-and-employers/ [https://perma.cc/E7TJ-RKFU] ("A 2010 study found that the average actuarial value (AV) — the percentage of total average costs for covered benefits that a plan will cover — of employer coverage was 83 percent, compared with 60 percent AV for plans in the individual market. Another study, in 2011, found that only about 2 percent of people covered by ESI had plans with value below 60% AV — equivalent to lowest-value metal tier, or bronze, coverage in the ACA marketplaces. The vast majority of ESI enrollees were in plans with an AV at or above 80%, which is gold tier in the marketplaces."); *Why Health Insurance is Important*, HEALTHCARE.GOV, https://www.healthcare.gov/why-coverage-is-important/protection-from-high-medical-costs/ [https://perma.cc/D48-B6NN] (last visited Aug. 15, 2023) (Once an insured's spending for covered services reaches their plan's deductible, the plan covers part of their medical expenses. A marketplace plan covers between 60% and 90% of their covered expenses after they've met their deductible.) No publicly available information suggested insurance policies currently cover nature-based health practices as described in this Article, so estimating the percentage of this coverage was necessarily hypothetical.

save the healthcare payer 20% of its average covered cost to treat CVD under baseline conditions — using available, conventional treatments.

2. *Number of Insureds receiving NT/NBS Health Programming in the Health Forest*. Cost estimates assumed treatment of 480 people per year per Health Forest.[205] This number assumed that each NT/NBS Health Programming session is one hour[206] and can accommodate at least 20 people;[207] that each participant attends a 1-hour group session three times per week;[208] and that each participant attends the sessions for 6 months.[209]

3. *Estimated Annual Net Revenue Calculation*. The avoided per-person cost (calculated under subparagraph 1) was multiplied by 480 people annually to arrive at annual total avoided CVD costs (or "gross revenues") of approximately $437,000. Financial estimates then take those "gross revenues," and net out from those savings the costs of annual operations, maintenance, and NT/NBS Health Programming for the Health Forest to arrive at estimates for annual net avoided healthcare costs for the healthcare payer (estimated to be approximately $125,000 per year for half-acre Health Forest). Given that Health Forests could have substantial therapeutic effects on CVD and many other chronic diseases (like hypertension and Type 2 diabetes mellitus), they could likely achieve a net healthcare cost savings (or

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205. One finding is that a half-acre forest can have a meaningful impact on 500-1000 people/year. Toker Thesis, *supra* note 19, at 38. Estimates also assume that all NT/NBS Health Programming sessions are fully subscribed by the first year of operations. *Id.* at 22.

206. Data suggests that sessions should be between 30 minutes to two hours, with one hour generally sufficient for optimal benefit. *See* Toker Thesis, *supra* note 19, at 59 (personal communications with AR1, AR2, P2, and literature review); *infra* App'x A–B.

207. Data suggests NT/NBS Health Programming groups are optimal between 5-30 people. *See* Toker Thesis, *supra* note 19, at 59 (personal communications with AR1, AR2, P2, and literature review); *infra* App'x A–B. Note that this model assumes that only one group of twenty people are in the ½ acre space at a time. Additionally, it may be possible to run two separate NT treatment programs in the ½ acre space (with 20 people in each program) at the same time. *See* Toker Thesis, *supra* note 19, at 59 (personal communications with AR1, AR2, P2, and literature review); *infra* App'x A–B.

208. Data suggests frequency should be at least once per week, but ideally should be more often. Therefore, the appropriate range of sessions per week per person is likely between one and five. *See* Toker Thesis, *supra* note 19, at 59 (personal communications with AR1, AR2, P2, and literature review); *infra* App'x A–B.

209. This assumption has the least amount of data to inform an appropriate range. The length of treatment in practice is exceptionally wide-ranging, and the duration of health benefit post-treatment is largely unstudied. Given the high weekly frequency, the analysis assumes that six months is sufficient. *See* Toker Thesis, *supra* note 19, at 59. In addition, ending treatment at six months may be a problematic assumption because treatment should occur on a regular basis over a long period of time. *See id.* However, there might be financial concerns that affect how often patients might be treated. An arrangement that reduces treatment sessions per week but extends over a longer period of time may also be an appropriate way to optimize health outcomes to combat cost worries. *See id*. There may be acceptable scenarios in which patients can pay a fee to continue receiving Health Forest treatments after the 6-month period ends. *See id.*

"net revenue") threshold that is much higher.[210] Financial sensitivity analysis conducted as part of this financial analysis suggests that there is tremendous potential for large financial returns using Health Forests, particularly if they are subsidized or acquisition costs are spread out over time.[211] In addition, as more conventional healthcare costs are offset, net present value rises drastically.

Discount Rate and Investment Time Horizon

The financial estimates used an estimate of 10% as the discount rate. This rate balanced two considerations: (i) common weighted average cost of capital ranges in the 7-9% ranges (in 2021-2022), but (ii) use of equity only could impose a higher cost of capital – potentially in the 12-15% range.[212] Financial estimates also showed a time horizon of 6 years to achieve full payback of initial costs.

Additional Considerations

1. *Avoided Healthcare Costs vs. Land Costs*. If land acquisition costs remain relatively stable, the main driver of the size of financial returns is the size of the healthcare expenditures that a healthcare payer can avoid by substituting conventional treatments with Health Forests, and the size of that cost avoidance is a function both of the magnitude of healthcare costs avoided per individual *and* the total number of people who can be treated. However, in a situation of rapid appreciation of land values across entire city regions, Health Forests can be priced out of reach unless those land costs are outweighed by greater-than-projected healthcare cost avoidance. The

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210. Research suggests that Health Forests can minimize related risk factors and co-morbidities. For example, allergies may be related to the increase of both type I and II diabetes, cardiovascular diseases, obesity, inflammatory bowel diseases, mental disorders, and cancer. Tari Haahtela et al., *Immunological Resilience and Biodiversity for Prevention of Allergic Diseases and Asthma*, EUR. J. OF ALLERGY & CLINICAL IMMUNOLOGY 3613, 3614 (2021). Although the financial estimates presented here focus exclusively on cardiovascular disease costs for the sake of simplicity, diseases like hypertension, depression, Type 2 diabetes mellitus, and heart disease often interact with each other (and accelerate deterioration) within individual patients, and they are considered co-morbid diseases. *See* Toker Thesis, *supra* note 19, at 8. Because initial investment in Health Forests is a fixed cost, avoiding expenses for additional and co-morbid diseases adds support to the notion that the model underestimates expenditure reductions. *See id.* at 25. It is important to note that, given the range of health benefits from NT/NBS, reasonable returns can be achieved even with fewer patients if those people are suffering from numerous co-morbidities and can be stabilized or cured before they need high-cost treatments.

211. *See* Toker Thesis, *supra* note 19, at 38–40.

212. Aswath Damodaran, *Cost of Equity and Capital (US)*, N.Y. UNIV. STERN SCH. OF BUS. (Jan. 2023), https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.html [https://perma.cc/KQT4-G4B6].

relationship of the magnitude of avoided healthcare expenditures to land acquisition costs is a key determinant of financial feasibility.

2. *Economies of Scale*. In addition to avoided per-patient healthcare costs, financial returns can be increased by achieving economies of scale through Health Forest networks. Although a given Health Forest may make financial sense, it may be of insufficient scale to be worth the effort of trying it; however, Health Forests could be installed in every neighborhood — and maybe multiple Health Forests per neighborhood. As the number of Health Forests increases, avoided costs among the insured population increase, and the transaction costs of assembling the right teams and legal structures can be spread across many projects generating revenue.[213] Installation of Health Forests will also improve other health measures of the entire surrounding community whether or not they are included in the NT/NBS Health Programming — a positive externality that may increase healthcare savings as well.

3. *Additional revenue from fee-for-service options*. It may also be possible for Health Forest owners to charge fees for: (i) leasing or licensing Health Forest space during periods not in use for subscriber NT/NBS Health Programming; (ii) allowing non-subscribers who live nearby to enter for a fee during "off hours"; or (iii) allowing people who are not subscribers to pay a fee to join NT/NBS Health Programming based on open slots in the programs.

2. How Large Could Financial Returns from Health Forests Be?

There is insufficient medical data to know precisely which chronic disease expenditures Health Forests could replace. Cardiovascular disease data, however, show that healthcare payers can gain high returns from any of: (i) large population-scale reductions in prescription drug use and office-based care for heart disease treatments,[214] (ii) avoiding deterioration cascades from

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213. *See* Toker Thesis, *supra* note 19, at 22–23. It's also the case that scaling up Health Forests can create a stable market demand for HPPs, allowing program delivery rates to stabilize and adjust to market demand. *Id.*

214. According to the data, most CVD treatments rely on prescription drugs and office-based medical care. 2017 allocation of CVD expenditures by treatment type for heart disease (most common treatments): 71.5% had prescription drug expenses, 67% had expenses for medical providers' office-based care, 15.2% had outpatient hospital visits, 13.6% had emergency room visits, 12.7% had inpatient hospital stays, and 6% had home health visits. Total medical expenditures for heart disease broken down by most-to-least expensive treatment type: Inpatient hospital care – 54.8% of CVD expenditures (most expensive); Home health care – second most expensive; ER & Outpatient hospital care; Office Based Care; Prescription drugs – 11.6% of expenditures (least expensive). *See generally* PRADIP K. MUHURI, STATISTICAL BRIEF #531: HEALTHCARE EXPENDITURES FOR HEART DISEASE AMONG ADULTS AGE 18 AND OLDER IN THE U.S. CIVILIAN NONINSTITUTIONALIZED POPULATION, 2017 (2020).

early stages (or risk factors) of heart diseases into the most expensive health treatments (e.g., inpatient hospital stays),[215] or (iii) prevention of heart disease entirely. Looking at the collection of data across healthcare costs and projected Health Forest efficacy, there is a reasonable likelihood that Health Forests could reduce costs in all these categories. For the highest cost treatments, even small percentage reductions due to (i) pure prevention or (ii) stabilizing diseases before they require high-cost interventions can have large potential benefits.[216] Financial returns could well exceed 30% internal rate of return as savings increase while the costs of Health Forest stabilize.

3. Summary

In summary, the best way to maximize financial returns is to identify and purchase many low-cost[217] parcels of land, of approximately one-half to one-acre size, that can be assembled into connected networks of Health Forests throughout urban areas. These parcels will ideally be located in or near neighborhoods that have high concentrations of insureds/subscribers[218] with high rates of targeted chronic diseases (or high rates of disease risk factors, including low-incomes, high levels of hypertension or diabetes, heat islands, and reduced access to safe, outdoor recreational areas).[219] This approach

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215. The most expensive CVD treatments are in-patient stays and ER/out-patient hospital treatments. *Id.* In-patient stays are 54.8% of annual CVD treatment expenditures, even though they represent only 12.7% of the treatment types used for CVD patients. *Id.* In total national healthcare spending, CVD is the second most common reason for hospital stays. *Id*. According to AHRQ, heart failure caused the second highest number of inpatient hospital stays in 2018. *See* KIMBERLY W. MCDERMOTT & MARC ROEMER, MOST FREQUENT PRINCIPAL DIAGNOSES FOR INPATIENT STAYS IN U.S. HOSPITALS, 2018 3 (2021).

216. *See e.g.*, Laurence Jones et al., *Urban Natural Capital Accounts: Developing a Novel Approach to Quantify Air Pollution Removal by Vegetation*, J. OF ENVT'L ECONS. & POL'Y 413, 413 (2019) (examining potential valuations of vegetation that reduces air pollution and hospitalizations).

217. Seeking to acquire "low cost" land serves both profit motives and the goal of access low- and-moderate-income areas that likely have concentrations of at-risk insureds; however, it only partially serves the goal of ecosystem restoration — given that ecosystem function is generally impaired in high-land cost areas as well as low-land cost areas. In locations with higher land costs, but ecosystem function support needs, government subsidies or community/nonprofit financial support may be necessary in order to ensure important regional ecosystem restoration outcomes. Alternatively, if such high-cost areas contain higher concentrations of insureds with chronic diseases, these increased potential revenues may also justify the increased acquisition costs.

218. Where neighborhoods of insureds are covered by a small number of healthcare payers, those healthcare payers could consider entering into a joint venture to pool acquisition and operating resources and then allocate cost savings/revenues on a pro rata basis.

219. To ensure affordability of land, minimize likelihood of need to demolish structures, and proximity to concentrations of insureds/subscribers, it will likely be important to locate within residential neighborhoods, either within neighborhood retail centers or residential neighborhoods themselves. However, this might create additional zoning and entitlement hurdles. *See infra* Section IV.B.

should result in health gains for socially vulnerable people and people at-risk for high cost diseases.[220] To marry financial goals with regional environmental goals, Health Forests should be located in areas that need stronger ecosystems to produce ecosystem services and networked into matrices that connect otherwise disconnected ecologically functioning areas. To ensure maximum social benefit as well as public support for each Health Forest, it will be best for all stakeholders if Health Forest owners and operators provide opportunities for local residents who are not insureds to access the Health Forests under specific circumstances. Such circumstances could include creating options for residents or occupants of surrounding neighborhoods to use the Health Forests at specified times for a fee (or at no charge). Such opportunities will build community goodwill and support for the installations and promote community stakeholder health. Pay-for-access arrangements could also supplement revenues from avoided healthcare costs and yield even higher financial returns from Health Forest operations.[221] In all circumstances, community stakeholders will need to be consulted and involved in avoiding potential eco-gentrification and displacement of low-income residents in surrounding neighborhoods.[222]

C. Downsides of Privatization and Profit Motives

There are a handful of important potential downsides to a purely privatized approach to Health Forests that can be managed through key partnerships, government action, and active stakeholder engagement. Although comprehensive consideration of these issues is beyond the scope

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220. Whether this overlap occurs will depend in part on whether concentrations of at-risk people are covered by private insurance companies or their employers. Although outside of the scope of this paper, government health coverage programs should consider similar approaches.

221. It will be important for Health Forests to garner community support for many reasons – including any public approvals required for entitlements. In addition, while Health Forests will create positive externalities to the surrounding community (through air, water, and heat island improvements), environmental justice communities have historically had inequitable access to nature, *see* DEP'T OF THE INTERIOR, REPORT: CONSERVING AND RESTORING AMERICA THE BEAUTIFUL (2021), https://www.doi.gov/sites/doi.gov/files/report-conserving-and-restoring-america-the-beautiful-2021.pdf [https://perma.cc/U3Q2-YBTZ], and Health Forests should not exacerbate this pattern. To assure strong community support and facilitate access to Nature, the owner/development team should consider allowing individuals to participate in subscriber programming or otherwise access the Health Forests for a fee. This may produce additional revenue, beyond avoided costs.

222. *See e.g.*, Zellmer & Goto, *supra* note 25, at 12 ("[C]are must be taken to consider placement of greenspaces so that they can improve the local environment without displacing low-income communities. Calling attention to and organizing community discussions around the issue of eco-gentrification is the first step in addressing this potential threat . . . "); *see also* Wolch et al., *supra* note 7, at 235 (discussing the need to balance access to urban green space as an environmental justice issue and avoiding eco-gentrification and displacement).

of this article, it will be important to manage some concerns. First, healthcare payer-investors will have incentives to maximize profits by serving as many insureds as possible within each Health Forest — beyond what may be optimal for the ecological sensitivity of the particular forest and possibly even reducing the magnitude of health benefits in the process.[223] Second, healthcare payer-investors may choose not to invest in drivers of ecosystem health (either at development or maintenance stages), except to the extent that high ecological value is essential to cost-reductive health outcomes.[224] Third, healthcare payer-investors will not want to bind Health Forest properties with long-term third-party protections to ensure continued use as a Health Forest into the future (an important feature discussed under below in Section IV.A on required roles). Fourth, healthcare payer-investors may not fund Health Forests in locations that are not easy to access for high concentrations of insureds/subscribers. Federal, state, and local governments may be able to manage some of these downsides by offering to invest their own healthcare funding into the costs of Health Forests in exchange for certain social and environmental guarantees from private owner-operators (e.g., long-term protections, access for non-subscribers, and ecological performance requirements of the Health Forests). Local governments could also require some of these social-environmental guarantees in exchange for zoning and other required approvals and permits. Cooperative agreements between Health Forest owners and neighborhood and homeowner associations may be another approach to building collective social and environmental value with privately owned Health Forests.

In addition, to potential social and environmental concerns, there are practical implementation challenges that private healthcare payers will face despite the potential value of privately owned and operated Health Forest networks. Corporate healthcare payers don't currently have the institutional capacity to create, manage, and maintain Health Forests as envisioned here. Healthcare payers have little or no expertise in acquiring land for forest regeneration, operating and programming forests for ecological or health outcomes, or managing natural lands for long periods. While healthcare payers could build this expertise in-house, doing so would be a substantial

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223. This concern should be minimized as experimentation with Health Forests and NT/NBS Health Programming refine determinations of optimally sized treatment groups for health and environmental benefit performance measures. Group sizes should be determined primarily by the HPPs, in consultation with Investors, rather than by Investors alone.

224. The problem of devaluing ecological health and environmental benefits may disappear if research can increasingly show correlations (or causal relationships) between indicators of ecological health and human health outcomes. This is quite probable. *See generally* Wood et al., *Not All Greenspace Is Created Equal: Biodiversity Predicts Psychological Restorative Benefits from Urban Green Space*, 9 FRONTIERS IN PSYCH. 1, 1 (Nov. 17, 2018).

change to standard operations and require a high-level organizational commitment. As a result, other stakeholders should participate to implement Health Forest networks successfully and in ways that harness the full range of benefits and ensure optimal performance outcomes. Part IV sets out the essential partnerships and possible legal structures that can achieve these goals.

IV. IMPLEMENTATION ROADMAP: NEW LEGAL STRUCTURES

This Part explores key roles and possible legal structures that (i) ensure Health Forest owners and operators are equipped to acquire, own, operate, and maintain Health Forests to maximize health, environmental, and financial outcomes, and (ii) hold the appropriate parties legally accountable for development, operations, and financial decisions (and ensure investors receive projected returns on their investments). Fundamentally, for Health Forest networks to be implemented successfully, new combinations of entities must fill a set of defined roles with specialized capabilities over the course of the different phases of acquisition, funding, predevelopment, design, ownership, operation, and maintenance of the Health Forest. These roles and capabilities are discussed below.

A. Required Roles

The essential roles for implementing a Health Forest are: (i) the landowner or long-term lessee (the "Landowner"), who will own or lease the land (and own the Health Forest) for long periods of time without requiring a change of use; (ii) the developer ("Developer"), who will plan and coordinate the overall acquisition, entitlements, regeneration, and facilities construction processes, while managing the other roles who play a part in these activities; (iii) the healthcare payer or other equity investor ("Investor"), who will invest the necessary capital to fund all phases of implementation;[225] (iv) the subscriber recruitment & relations ("SR") team, who will identify and target (and map the spatial distributions of) subscribers at-risk for — or who have a diagnosis of — a targeted chronic disease and who will recruit targeted subscribers for NT/NBS Health Programming; (v) the designer, who will design the Health Forest to promote key drivers of ecosystem health, design for low maintenance, and incorporate key features for NT/NBS Health Programming; (vi) the general contractor (GC), who will remediate any adverse existing site conditions, prepare site (which could involve demolition, removal of impervious surface or invasive species, and soil rehabilitation), plant native forest and habitat, and install required facilities

225. The Investor will need either "patient" capital (i.e. long-term investments) or access to multiple sources of low-cost capital over extended periods of time.

and essential parking; (vii) the property manager and operator ("PM"), who will oversee and manage all aspects of property operations and maintenance, including forest management for ecosystem services, facilities management, record-keeping and expense payments, legal compliance, and management of all service delivery in the Health Forest; (viii) the health program provider (HPP)[226], who will deliver the range of nature-based health practices appropriate to the target treatment population and the particular Health Forest; (ix) the community/stakeholder relations team ("CR"), who will conduct community outreach to build local community understanding and support for use of the space as a Health Forest; and (x) the long-term protector (LTP)[227] of the Health Forest, who will ensure that the use, operation, and maintenance of the Health Forest maximizes and prioritizes ecological and health benefits equally over extended periods of time.

A whole range of companies could map onto these required roles in interesting ways. Examples of the kinds of individuals and companies who could strategically partner to perform some of the required roles are: health insurance companies; philanthropies; investment funds, consortia of healthcare payers, real estate developers, corporate landowners or real estate investment trusts (REITs) (e.g., retail mall owner, large landowner); public relations firms; community organizers; homeowner associations; ecological restoration companies; certified nature therapists, doctors, nurses, and rehabilitation specialists; urban forest managers and timber investment management organizations (TIMOs); real estate management firms; security teams; and land trusts. For example, a traditional real estate property management firm could partner with an urban forester and certified nature therapist to become the PM for the Health Forest. Alternatively, a TIMO could become the PM and retain a traditional real estate property management firm, ecological restoration firm, and a security team as contractors to assist in certain operation and maintenance tasks as necessary. The options for combining environmental, health, and real property expertise into different roles are myriad.

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226. *See supra* note 21 and accompanying text.

227. The Author recognizes that the Investor and Developer will have no financial incentive to grant property rights to any entity in the LTP role unless the LTP can materially increase financial returns or project risk. This likely means that, to incorporate the LTP, either (i) the public sector (through entitlement processes or attached to subsidies or other incentives) must require that an LTP be involved or (ii) the LTP will need to contribute funds or other benefits that boost financial returns to the project. It is the case that Health Forests can exist without an LTP, but, in that case, they will remain at risk for conversion to other uses in the future.

B. Essential Capabilities During Development and Ownership Timeline

Development and ownership of Heath Forests will be implemented in phases that include subscriber targeting and recruitment; site acquisition; predevelopment and entitlements; installation and restoration of Health Forests (and related facilities); property management (including NT/NBS Health Programming, operations, and maintenance); and long-term protection. Appropriate entities must partner in ways that fill the required roles and combine the key capabilities needed to perform each of the different phases of implementation (described further below). The Investor will necessarily be involved in all phases in order to protect its investment, but not always to the same extent. The relative control of the Investor as compared to actors in other core roles during the various phases will depend on the desires of the Investor and the relative capabilities and bargaining power of the various entities involved. How decision-making power is shared will depend on specific negotiations for ownership and operation of each Health Forest, and expert legal teams will play a key role in each of these negotiations.

1. *Subscriber Targeting & Recruitment*: Maximizing profits will require focused recruitment and treatment of at-risk insured/subscriber populations. The subscriber recruitment team must be able to identify and target concentrations of insureds with target diseases. This information will need to inform site acquisition/placement,[228] facilities design and construction,[229] and recruitment communications for NT/NBS Health Programming. Therefore, SR teams must work with acquisition and development teams to determine acceptable Health Forest locations and features. Then SR teams will need to work carefully with medical doctors, HPPs, and other parts of the healthcare delivery system to recruit for NT/NBS Health Programming. Core roles leading this phase will be the SR teams and HPPs, with support from CR as needed. *Potential entity partners and consultants should include healthcare payer patient tracking departments, nature-based healthcare providers working with primary care physicians (and other subscriber treatment teams) who can help identify both local population and patient needs with respect to prevalent chronic diseases (both to identify potential targets for prevention and for patients already in treatment for key chronic*

228. Maximizing insured participation in NT/NBS Health Programming will require ease of access and proximity for target insureds. *See generally* Wolch et al., *supra* note 7; Williams et al., *supra* note 138; *see also supra* notes 128–29 and accompanying text.

229. For example, if target populations are not within walking distance to the area, various mobility options and associated facilities must be made available to access the Health Forest, which will inform its design and construction.

diseases). This phase must be closely coordinated with site acquisition and design.

2. *Site acquisition*: The acquisition team must be able to select, price, and purchase appropriate sites for Health Forests. This will require an understanding of urban land dynamics and valuation, real estate finance, project and operating budgets/anticipated cash flows, private partnerships/joint venture structures, zoning and entitlements, urban stakeholder relationships[230] and the history of the urban neighborhoods targeted, risks of urban land development, and how to lay a foundation for smooth property management and operations. Core roles leading this phase will be the Developer and SR team, with support needed from Designer and HPP. *Potential entity partners and consultants will include a real estate developer with experience developing projects in the urban location, the healthcare investor's subscriber communications team, developer or investor's stakeholder engagement team, GIS advisors who can map subscriber locations, and urban forest managers*.

3. *Predevelopment and Entitlements*: This team must be able to design the Health Forest to achieve health, financial, and ecological goals — including required facilities, vegetation and hardscaping — within a projected budget. This team must design in accordance with zoning requirements and obtain any zoning exceptions and building permits.[231] In some cases, the Health Forest design may incorporate art, history, and local culture in order to ensure a sense of comfort and safety for the participants. The installation will also need to be designed to ensure security,[232] safety, ease of access, and sufficient facilities to address physical limitations of participants, weather variability, and sanitation. Core roles leading this phase will be Developer, Designer and GC, with input and implementation

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230. Stakeholders would include business improvement districts, special assessment districts, neighborhood leaders and political representatives, and other local public entities or officials that may operate in the target neighborhoods.

231. In the context of a Health Forest, it is unclear whether zoning and related entitlements would create additional legal hurdles. The primary challenge would be that such a land use is relatively novel and local government agencies might not know which codes and regulations to apply. Health Forests would likely fall within commercial, retail, or healthcare land uses. Whether or not there would be legal difficulties obtaining permits to operate Health Forests within residential zones would likely depend on the jurisdiction and its views on the need for green infrastructure within the target neighborhoods.

232. However, depending on the location, circumstances, and surrounding neighborhood, Health Forests may require fencing and physically controlled access to the site. Fences and similar physical barriers are often problematic when promoting biodiversity and healthy animal populations. These are conflicts that will need to be assessed, minimized and adaptively managed to ensure both ecological and health priorities are served. Specific solutions are beyond the scope of this Article and may require further research. For additional discussion of this topic, see Zellmer & Goto, *supra* note 25, at 8–11.

support from the HPP, SR team, and CR. *Potential entity partners and consultants will include the lead developer; landscape architects, sustainable designers, or ecological restoration companies; civil engineer teams; nature-based healthcare providers; zoning advisors or expediters; and community/stakeholder engagement contractors*.

4. *Installation and Restoration*: This team will need to know how to regenerate or restore native forests and healthy soils, in addition to knowing what kinds of features support and enrich NT/NBS Health Programming and ensure a sense of safety. Core roles leading this phase will be Developer, Designer, and GC, with support from CR and input from HPP and SR team. *Potential entity partners and consultants will include traditional real estate general contractors, landscape companies, ecological restoration companies, urban foresters, nature-based healthcare providers, and the design team as needed*.

5. Property Management — Operations/Health Programming and Site Maintenance: This team must be able to collect fees, oversee facilities, manage security and occupancy control, and ensure maintenance of forests and health program facilities and features. Various health programs will need to be planned, developed, and operated in the space for treatment populations. NT/NBS Health Programming should incorporate expertise specific to the ecology and treatment populations. Site maintenance will include vegetation management, maintenance of natural and man-made features within the NT/NBS to ensure safety, comfort, and ecological health. Core roles leading this phase will be the PM and HPP, with input and oversight from Landowner, CR, and LTP. *Potential entity partners and consultants will include the nature-based healthcare providers, facilities manager, and urban forestry/ecology consultants who must actively work together to ensure effective health operations that facilitate (and do not interfere with) forest health; community engagement and public relations will need to be managed throughout operational life of Health Forest as well. At all times, the entity providing long-term protection will need to make sure that operations and maintenance are consistent with long-term, ecological goals.*

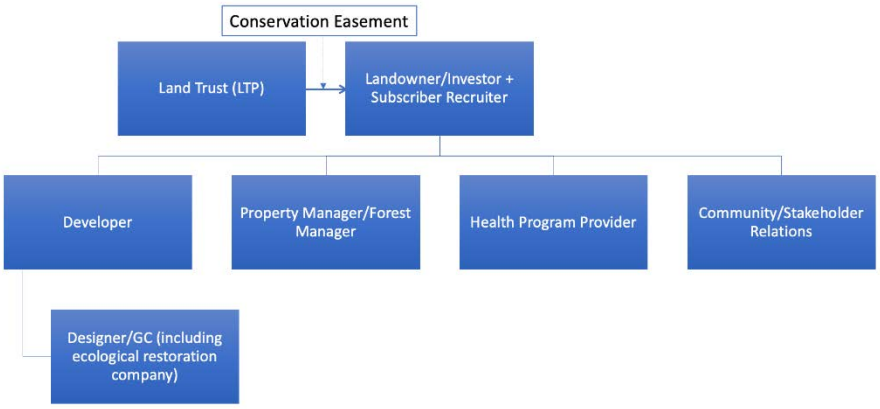
6. *Long-Term Protection*: Health Forests should be protected for extended periods of time — at least for as long as key health and ecological objectives can still be met using the space. If such objectives are being met and there continues to be a positive return on investment for investors, the use of the property as a Health Forest should continue even if there is a more lucrative use that can be made of the land; otherwise, the Health Forest will be at frequent risk of conversion to other uses. The LTP will lead this phase and must be capable of monitoring and overseeing the use and maintenance of the Health Forest and be able to identify when environmental and health objectives are no longer being targeted or optimized. The LTP should also

be capable of enforcing its right to ensure the long-term use of the land as a Health Forest. *Potential entity partners and consultants may include a conservation land trust, a local or state agency with land management or conservation responsibilities, or a community association (like a homeowners' association or local community cooperative) that is advised by, and accountable to, a natural resource agency or nonprofit.*[233]

C. Sample Legal Structures that Support Implementation

There are a variety of ways that the stakeholder teams can structure their collaboration to ensure that the right entities carry the right expertise into the right roles at the right times. The legal relationships of these actors can look similar to traditional real estate ownership, development, funding, and operation models. However, in this case, the entities with essential capabilities working within those structures will vary from the norm to ensure they can achieve target outcomes and benefits. To align capabilities with legal risks and responsibilities, here are two possible legal arrangements of entities and their associated capabilities.[234]

EXAMPLE SCENARIO 1: INVESTOR OWNS AND CONTROLS



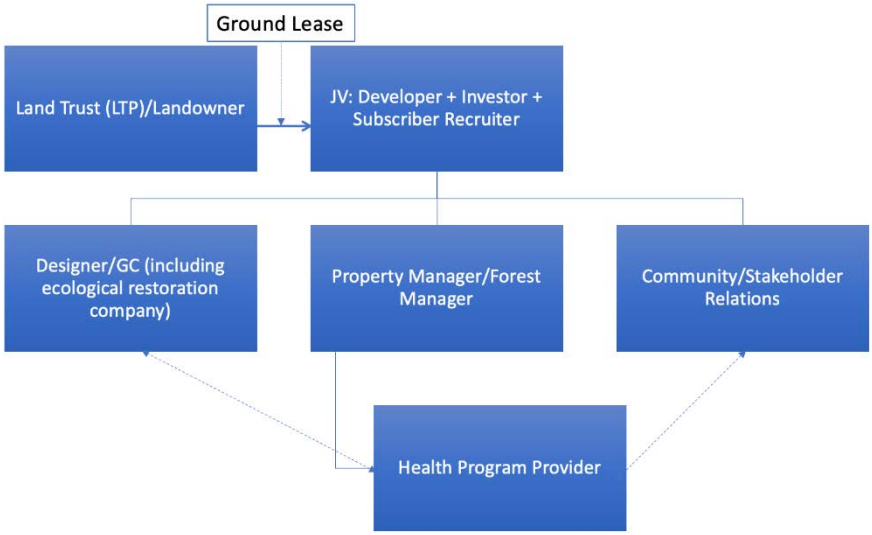
In Scenario 1, the Landowner is the Investor (i.e., healthcare cost payer), and this model assumes that the SR team is either in-house at the Investor or that the SR team has a close, long-term, and pre-existing working relationship with the Investor. Here, Landowner/Investor enters into a long-

233. Where Landowners and Investors are not required to incorporate an LTP and are not required to by the local jurisdiction or as part of the land acquisition strategy, LTP may not be incorporated in all Health Forest legal structures.

234. These scenarios assume an LTP is included.

term agreement with LTP (most likely a conservation easement) that ensures the LTP has the right to oversee Health Forest operations and maintenance and ensure that it maximizes ecosystem health as well as human health objectives for an agreed-upon term of years (or in perpetuity). In this scenario, the Landowner/Investor controls the entire project, subject to LTP rights, and retains, as contractors, all of the other entities needed to perform different roles. Although the Landowner/Investor likely does not have the internal capabilities for site acquisition, predevelopment, operations, or maintenance, Landowner/Investor will retain Developer for site acquisition and predevelopment, and Developer will be responsible for delivery of the Health Forest in a condition agreed upon by Landowner, Developer, and Designer/GC (who will be retained by Developer and have specialized expertise in ecological restoration). Landowner/Investor will then separately retain PM, HPP, and Community/Stakeholder Relations firm to provide long-term operations and maintenance as well as general community support for the operation. This makes the most sense for Investors who already have relationships with marketing firms, nature-based healthcare providers, and a portfolio of properties that use third-party real estate management services. In this scenario, the Landowner/Investor maintains much more control and oversight over the entire process than in Scenario 2 — and in doing so, can ensure the project is maximally serving its targeted insured population and meeting its financial targets. In cases where the Landowner/Investor owns a portfolio of Health Forests — as mentioned above under the benefits of economies of scale — the PM, HPP, and Community/Stakeholder Relations teams could all be retained to manage the entire portfolio, reducing transaction costs and creating consistent levels of quality across the network. The LTP should play an active role to ensure that the Health Forest serves ecological goals and is maintained appropriately during the operational period.

EXAMPLE SCENARIO 2: DEVELOPER LEADS UNDER A JV STRUCTURE



In Scenario 2, the LTP owns the Health Forest as the Landowner. In this scenario, the Developer and the Investor would form a joint venture (JV) that could also include the SR team. The JV could ground lease the land from the LTP, potentially for as long as 99 years, which would restrict use of the land for Health Forest purposes, and then the JV would develop, construct, and operate the Health Forest.[235] In this scenario, one acquisition strategy could be to use the Investor funding to cover the LTP's land acquisition costs, whereby the JV ground leases the property simultaneously with the LTP's acquisition of fee title (such that the JV would make an up-front payment of ground rent to the LTP under the ground lease that is sufficient to fund the LTP's acquisition cost). Alternatively, the JV could acquire title to the property initially, and then sell the land to the LTP at a nominal price and lease back the property — also at a nominal price — either before or after installation of the Health Forest. If the LTP owns the land already or has separate funding or financing for acquisition, the JV could make annual ground rent payments under the ground lease to the LTP, which would allow the JV to spread the costs of acquisition across the operational life of the Health Forest. The ground lease agreement can contain a right of the JV to purchase the land after a certain term of years or other future milestone (or the ground lease may simply terminate and leave unencumbered fee title with

235. Alternatively, the JV could enter into a partnership with the LTP, with that partnership owning the property.

the LTP). In this scenario, the JV, led primarily by the Developer, will manage all roles involved in predevelopment, design, construction, operation, maintenance, and health operations. In all cases, the roles of PM and HPP should be closely coordinated at all times, and their incentives should be aligned through collective performance measures to ensure cooperation. Designer and CR should consult with HPP, to understand the programs and local health needs, as they perform their roles during this phase. In this structure, the Developer will take primary responsibility from within the JV for ensuring successful installation and launch of Health Forest operations on behalf of the Investor. Once installation is complete and after a certain period of successful operations, the JV parties may elect to transfer control of the JV to the Investor so the Developer can exit.

CONCLUSION: THE TIME IS NOW

We are at a point in time where NT/NBS — and specifically Health Forests — can and should be a central component of the urban response to ecosystem degradation, climate change, environmental inequities, and the crushing burden of chronic disease. The data show that NT/NBS, optimized as Health Forests, can be a cost-effective, broad spectrum, and financially sustainable way to solve, or at least minimize, these major social and environmental urban problems. Healthcare payers currently paying to treat expensive chronic diseases stand to create substantial value and financial returns by investing in networks of Health Forests as imagined in this Article.

Unfortunately, there is a time pressure to prioritizing NT/NBS as a solution to these crises for at least four reasons. First, ecosystems of all types and at all scales are under increasing stress from climate change and human degradation, and, under current trajectories, there may come a time when native ecosystems are degraded to the point where they cannot be rehabilitated. Second, urban populations are increasingly disconnected from nature in ways that promote disease and accelerate the rise of already unsustainable healthcare costs.[236] Third, this disconnectedness and reduced contact with outdoor Nature produces a self-reinforcing "extinction of experience" that reduces people's willingness and desire to invest in, and

236. See Bratman et al., *Nature and Mental Health*, *supra* note 7, at 1, 2–3 ("In many instances, modern living habits involve reduced regular contact with outdoor nature and increased time spent indoors, on screens, and performing sedentary activities."); *see also* Bikomeye et al., *supra* note 7, at e0276519 ("Neighborhood social and built environments, including nature and greenspaces, are key determinants of health and important factors in predicting health outcomes, including for CVD and cancer. Recent estimates suggest that 70%-80% of CVD burden might be attributable to non-genetic environmental factors, such as lifestyle choices, socioeconomic status (SES), air pollution, lack of neighborhood greenness, and poorer residential characteristics."); *see also* Shanahan et al., *supra* note 10.

partner with, Nature to find solutions. That is, "as direct nature experiences become progressively unavailable to new generations, this creates an ever-narrowing spectrum of nature experiences — [leading to] an 'environmental general amnesia' . . . [that shifts] the baseline of reference points for the acceptable quality, richness, and variation in nature experience." As this happens, people become increasingly uninterested and even afraid of Nature as the unknown,[237] causing people to turn elsewhere for solutions and potentially even weakening the beneficial effects Nature has on our bodies and minds. Without market demand for, and under the specter of potentially reduced health benefits from, urban NT/NBS (like Health Forests), the private sector will continue to turn to technological and pharmaceutical responses that produce corporate profits but do not reverse profound health or environmental threats. Fourth, as urban populations continue to grow, urban land becomes increasingly scarce and expensive — potentially placing the cost of land for Health Forests out of reach.

Growing a distributed network of urban Health Forests, owned and operated to specific standards, can provide the unified response we need to ecosystem loss and chronic disease in urban regions. By consciously working with Nature to achieve ambitious ecological and human health objectives, people can help the environment, create new economic markets, alleviate economic stressors, improve community health, and begin to address key environmental injustices more cost-effectively than they do. It is time for us to think differently and put new nature-based options on the metaphorical table. Corporate healthcare payers stand to gain substantially if they begin experimenting with the creation and implementation of Health Forests now. In fact, we all do.

237. *See* Bratman et al., *Nature and Mental Health*, *supra* note 7, at 3.

APPENDIX A – LIST OF INTERVIEWS WITH NATURE-BASED HEALTH PRACTICE ORIENTATIONS

Individual	Subject Matter Expertise	Location	Interview Date
Academic Researcher 1 (AR1)	University – Research Social Scientist trained in Landscape Architecture	Pacific Northwest	July 6, 2021
Practitioner 1 (P1)	Non-profit – Environmental NGO/Nature Experiences & Social Programming	Pacific Northwest	July 7, 2021
Practitioner 2 (P2)	Nonprofit – Environmental NGO/Public Health & Educational Programming	Pacific Northwest	July 7, 2021
Practitioner 3 (P3)	Nonprofit – Public Parks and Health	Washington, D.C. metropolitan area	July 8, 2021
Academic Researcher 2 (AR2)	University – Architecture, Landscape Architecture, and Therapeutic Gardens	Maryland	Sept. 24, 2021; Sept. 29, 2021
Practitioner 4 (P4)	Hospital – Nursing and Therapeutic Gardens	Pacific Northwest	Oct. 28, 2021

APPENDIX B – LIST OF INTERVIEWS WITH CONVENTIONAL HEALTHCARE SYSTEM ORIENTATIONS

Individual	Subject Matter Expertise	Location	Interview Date
Healthcare Consultant 1 (HC1)	Quality of healthcare/patient outcomes/public health	Washington D.C. metropolitan area	July 14, 2021
Doctor in Regional Hospital System (D)	Population Health	Mid-Atlantic	Aug. 10, 2021
Healthcare Consultant 2 (HC2)	Advisor to healthcare insurers and large employers	Washington, D.C. metropolitan area	Sept. 9, 2021
Insurance Company Employee (ICE)	Population Health	West Coast	Sept. 20, 2021