HEALTH FORESTS: SCALING UP URBAN FORESTS AS A HEALTH RESPONSE

By

Rachel Toker

Professor Nicolette Cagle, Adviser
Professor Joseph Bachman, Adviser

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Approved on April 21, 2022, by:

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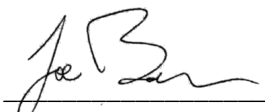
Professor Nicolette Cagle



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Inspired by a Japanese botanist, these mixed-species copses can absorb more carbon than conifer forests. Image: Unsplash/DesignEcologist

https://www.weforum.org/agenda/2020/07/tiny-urban-forests-miyawaki-biodiversity-carbon-capture/

https://pixabay.com/photos/the-park-winter-russia-city-park-1489020/

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EXECUTIVE SUMMARY

This MP focuses on responses to three wicked problems – problems that are complex, multi-sectoral, and partially undefined, unknown, or situationally-specific and that defy simple solutions. These 3 wicked problems are: (i) the rise of chronic diseases in American cities; (ii) the expanding role of cities in ecosystem degradation even as they suffer intensely from the effects of it – compounded by an inability to stop either process; and (iii) the persistent failure of cities to see nature as a partner in solving the other two problems.

By beginning to address the third wicked problem first, we can confront the other two problems from a new perspective – one that helps us address all three. This approach led me to investigate the array of nature-based healthcare responses now starting to enter mainstream consciousness. As discussed in depth in the Results/Findings section, Nature Therapy (NT) is a nature-based solution that offers us a new entry point into solving the three wicked problems collectively, comprehensively, and efficiently. It can also expand available funding sources for urban nature – by allowing the private sector to monetize some of nature's benefits in the form of avoided healthcare expenditures -- while adding a new element to the emerging "green economy" of the United States.

Research across a variety of professional fields demonstrates that people of all ages need to interact and connect with nature to maintain healthy lifestyles. Numerous stakeholders, including government agencies, environmental nonprofits, landscape architects, educators, public and mental health advocates, and park advocates, have started to study and design programs that use human-nature connections to positively affect human health. Hansen et al. (2017) have collected research findings demonstrating NT's therapeutic effects on: (1) immune system function, (2) cardiovascular system function, (2) respiratory system function, (4) depression and anxiety, and (5) mental relaxation, attentional, and related disorders (including ADHD).

Building on studies of the Japanese practice of Shinrin Yoku (*The Origin of Forest Bathing & Forest Therapy*, 2019), practitioners and researchers around the world have begun experimenting with a wide range of human-nature experiences to promote health, including: (a) rehabilitation gardens, like the Stenzel Healing Garden (Rehabilitation Institute of Oregon) at Legacy Hospital (b) camping/hiking in wilderness areas (Willamette Partnership), (c) prescriptions to exercise in public parks (Park Rx America), (d) areas with nature and spiritual features combined (NatureSacred), (e) forest bathing trails and guided meditation walks in nature (ANFT) (f) nature play spaces for kids (generally at schools) (NEEF, Green Schoolyards), and (g) outdoor areas for patient support groups and family recuperation (Walter Reed/Green Road). Professionals in the nursing, public health, physical rehabilitation, and landscape design sectors continue to experiment with these nature therapies – despite the lack of published medical research on the topic – because they are steadily identifying connections that prevent and heal illness, promote health, and enrich people's lives (Frumkin, 2013; Fisher et al., 2021; Bratman et al., n.d.).

However, despite mounting evidence of substantial human health benefits from certain kinds of nature experiences, the scientific community has not reached consensus on how to optimize these nature experiences for the best health outcomes, nor have stakeholders – or the ad hoc programs using nature experiences for health – committed to using these practices to support ecosystem restoration as well as human health, despite their underpinnings in nature. Furthermore, while a collection of advocacy movements and individual programs is seeking to legitimize and entrench nature-based health practices, there is no organized attempt within medical circles or the larger healthcare industry to employ these practices for disease prevention or treatment, or to cover them as medical expenditures (under health insurance policies) for the prevention and treatment of disease.

Through literature reviews and interviews with practitioners, researchers, and healthcare professionals, I set out to understand how these wicked problems intersected, what nature-based solutions could offer in response, and what the core obstacles are, within the healthcare sector, to using and funding nature-based therapies for highly prevalent, high-cost diseases among urban populations. In addition, I explored how to design, locate, and conduct nature-based therapies so that they maximize health and ecological restoration outcomes and prioritize both outcomes equally. Finally, I considered how to attract funding from third-party corporate healthcare payers for such purposes using a financial model to estimate hypothetical returns on investment.

Previous research has focused on whether and what kind of nature exposure works for improving various health outcomes among different populations, but the following gaps in data remain, leaving the doors to implementation locked:

(i) practitioners have been unable to identify key features of NT that optimize health outcomes or to collect health efficacy data in a manner sufficient and convincing to medical and healthcare investment decision makers (Wood, 2017; Frumkin, 2013; HealthPayerIntelligence, 2021), and
(ii) few studies consider the financial feasibility or cost-benefit analysis of using nature-based solutions, which is necessary for private sector participation (Fisher et al., 2021).

My research combines the findings from existing research studies with the anecdotal experiences of practitioners in the field and financial modeling to provide rudimentary responses to these two data gaps sufficient to support further research and study that specifically addresses them.

My findings suggest that using native forest patches under the following parameters (in what I call "Health Forests") could optimize both health and environmental outcomes in the most cost-effective way:

(i) locate native forest patches across urban neighborhoods (particularly in those with high prevalence of targeted, high-cost diseases),
(ii) design, control, and manage for health and ecological purposes,
(iii) run health programs for individuals and groups,
(iv) ensure safety, security, and crowd control for the space.

Based on my financial model, if Health Forests can reduce even 20% of the average covered healthcare expenditures for cardiovascular diseases, third-party healthcare payers could reap substantial financial benefits from funding the creation and operation of Health Forests. Research also suggests that Health Forests could reduce expenditures attributable to many other highly prevalent, chronic diseases.

Further research should specifically examine which currently covered healthcare expenditures could be avoided using Health Forests, and third-party healthcare payers should begin funding pilot studies of the effect of Health Forests on healthcare expenditure reductions.

INTRODUCTION

As local and regional ecosystems in the mid-Atlantic region of the U.S. deteriorate under the weight of urban expansion, cities are experiencing a wide range of problems. Fueled by urban growth dynamics, natural ecosystems in and around cities are under increasing strain, ecosystem services are diminished, and urban populations are increasingly distanced from natural settings.

THE "WICKED" PROBLEMS

In this urban context, three "wicked" problems are converging:

(i) **Rise of Chronic Diseases**: urban lifestyles, land uses, and configurations are causing (or contributing to) the national rise in chronic diseases in cities (Shanahan et al., 2016b). Public health spending on chronic diseases among urban populations is increasing from already massive levels in the billions of dollars (Raghupathi & Raghupathi, 2018).

(ii) **Ecosystem Degradation**: Widespread ecosystem degradation is causing two accelerating global environmental catastrophes (e.g., climate change and rapid biodiversity loss), with major effects on cities across the globe. It has become essential to restore health to ecological systems across regional landscapes, including those that contain expanding cities.

(iii) **Failure to Search for Nature-Based Solutions**: Despite calls from the international community to seek out nature-based solutions for environmental problems, the U.S. urban and medical communities have failed to prioritize ecological restoration and to perceive these calls as potential responses to human health problems (Frumkin, 2013; Fisher et al., 2021) as well as environmental problems. The U.S. medical community, in particular, has largely ignored nature's potential to address public health, disease prevention, and treatment of chronic disease.

What's a Wicked Problem?

Wicked problems are complex, multi-sectoral, situationally-specific, and partially undefined problems (*What's a Wicked Problem?*, n.d.) They are large-scale, long-term policy dilemmas in which multiple and compounding risks and uncertainties combine with sharply divergent public values to generate contentious political stalemates; with the environment, they typically emerge from entrenched conflicts over natural resource management and the relative prioritization of economic and conservation goals. (*Wicked Environmental Problems*, n.d.)

CHRONIC DISEASE AND NATURE

Chronic diseases are on the rise. Currently, the top ten health problems in America (not all of them chronic) are heart disease, cancer, stroke, respiratory disease, injuries, diabetes, Alzheimer's disease, influenza and pneumonia, kidney disease, and septicemia. More than 75% of the $2 trillion spent on public and private healthcare in 2005 went toward chronic diseases. Chronic conditions are particularly challenging to manage because they often occur together (as "co-morbid" conditions). Today one in four U.S. adults have two or more chronic conditions, while more than half of older adults have three or more. And it is likely that these types of comorbidities will increase greatly in the near-term (Raghupathi & Raghupathi, 2018).

At the same time, research across a variety of professional fields demonstrates that people of all ages need to interact and connect with nature to maintain healthy lifestyles. Government agencies, environmental nonprofits, landscape architects, educators, public and mental health advocates, and park advocates have

started to explore health-nature connections to promote human health. Certain kinds of "nature experiences" can have substantial positive effects in the treatment of medical disorders like hypertension, heart disease, obesity, diabetes, post-surgical recovery and psychosocial conditions like depression, stress reduction, post-traumatic stress disorder (PTSD), and attention deficit hyperactivity disorder (ADHD) (Chaudhury & Banerjee, 2020) (Hansen et al., 2017); they can also lower blood sugar, improve concentration, diminish pain, and improve immunity (*Forest Therapy, Forest Therapy Association of North America Health Benefits*, n.d.; Hansen et al., 2017).

Yet, despite existing evidence, there is little apparent attempt within medical circles or the healthcare industry to employ these practices systematically for disease prevention or treatment, nor is there any consideration within the healthcare industry of expanding access to such programs or environments, let alone incorporating them as "covered" medical expenditures for the prevention and treatment of disease.

ECOSYSTEM DEGRADATION AND NATURE

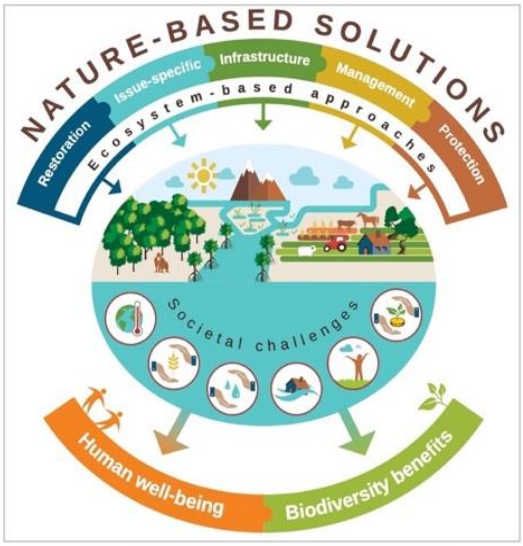


Figure 6. NbS as an umbrella term for ecosystem-related approaches

FIGURE 1
HTTPS://PORTALS.IUCN.ORG/LIBRARY/SITES/LIBRARY/FILES/DOCUMENTS/2016-036.PDF

As research in non-medical fields is uncovering the many positive health effects of nature experiences on people, scientists and global policy makers are simultaneously recognizing the need to use nature-based solutions to mitigate (and adapt to) accelerating climate change, extreme weather, and biodiversity loss due to their multiple and systemic benefits. Ironically, these benefits include the mitigation of intense heat, which can trigger heat stroke in patients with chronic diseases, like heart disease (*Heat Exposure and Cardiovascular Health: A Summary for Health Departments*, n.d.) (*Managing Heart Disease in the Summer Heat*, n.d.) (*IUCN Global Standard for Nature-Based Solutions*, 2019). More specifically, international NGOs and governments around the world are recognizing the importance of nature-based solutions in cities. As noted in a new white paper published by UNECE: "Urban trees, forests, and green spaces [are] important components of more livable, healthy, and resilient cities. Functioning urban ecosystems help clean our air and water and to cool urban heat islands. They also help to support our well-being by shielding us from floods and landslides and providing opportunities for recreation." (*Sustainable Urban and Peri-Urban Forestry: An Integrative and Inclusive Nature-Based Solution for Green Recovery and Sustainable, Healthy and Resilient Cities | UNECE*, n.d.).

Yet, despite these calls for nature-based solutions and ecosystem restoration, most cities have not implemented or scaled up ecological responses that restore local or regional ecosystem function at the magnitude required to address the present environmental challenges (*Trillions Are Being Committed to Climate Mitigation, but What about Climate Adaptation?*, n.d.) (*Hunting for Money*, n.d.).

CITIES AND NATURE

The dual need to restore urban ecosystems and to reverse certain declines in public health (and related increases in healthcare spending) is essential for urban populations – and our national economy – to survive

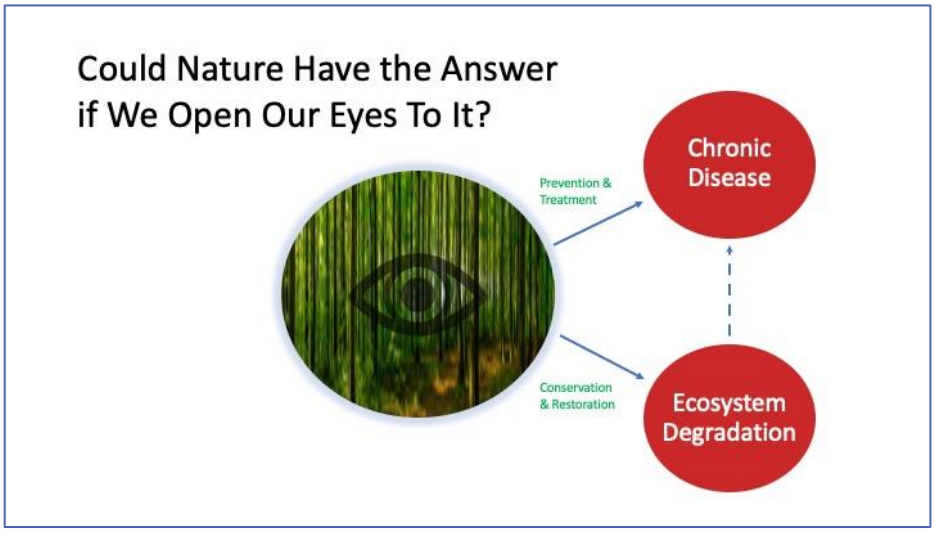
and thrive. Meanwhile, though these crises were once relatively independent of one another, now, environmental degradation, expanding urban populations, and declining population health are negatively affecting each other – a process that climate change will intensify as it accelerates (*Climate Change and Health*, n.d.) (*Heat Exposure and Cardiovascular Health: A Summary for Health Departments*, n.d.).

Despite the urgency of addressing these health and environmental issues, neither the public nor the private sectors have sought to prioritize nature-based solutions or to coordinate their responses in ways that address all of these problems simultaneously. Furthermore, the most unlikely response is one that seeks to optimize both environmental and health outcomes equally. Private sector action that could substantially accelerate positive change has proven particularly elusive.

The problems of (i) increasing chronic disease and (ii) planetary ecosystem decline are wicked problems. *Yet, health policy makers, investors, and medical researchers, on the one hand, and, to a lesser extent, climate resilience policy makers and advocates, on the other hand, are looking everywhere but to nature-based solutions to address both problems with a unified place-based response. And, without adequate sources of funding, urban nature – a key component of the solution to both – remains under-resourced and under-provided (for health and ecological needs) (Wolf et al., 2020).*

CONFRONTING THE WICKED PROBLEMS

What if we addressed these wicked problems starting with the search for a unified, nature-based response that is specifically designed to systemically confront the first two wicked problems?



By beginning to address the third wicked problem first, we can confront the other two problems from a new perspective – one that can help us address all three. This approach led me to investigate the array of nature-based health responses now starting to enter mainstream consciousness. As discussed in depth in the Results section, Nature Therapy (NT) is a nature-based solution that can offer a new entry point into solving the three wicked problems collectively, comprehensively, and efficiently. Furthermore, it can expand available funding sources for urban nature – by allowing the private sector to monetize some of nature's benefits in the form of avoided healthcare expenditures – while adding a new element to the emerging "green economy."

Hansen et al. (2017) have identified research findings demonstrating NT's therapeutic effects on: (1) immune system function, (2) cardiovascular system function, (2) respiratory system function, (4) depression and anxiety, and (5) mental relaxation, attentional, and related disorders (including ADHD). Beginning with studies of the Japanese practice of Shinrin Yoku (*The Origin of Forest Bathing & Forest Therapy*, 2019), practitioners and researchers around the world have begun experimenting with a wide range of human-nature experiences and connections to promote health, including: (a) rehabilitation gardens, like the Stenzel Healing Garden (Rehabilitation Institute of Oregon) at Legacy Hospital (b) camping/hiking in wilderness areas (Willamette Partnership), (c) prescriptions to exercise in public parks (Park Rx America), (d) areas with nature and spiritual features combined (NatureSacred), (e) forest-bathing trails and guided meditation walks in nature (ANFT) (f) nature play spaces for kids (generally at schools) (NEEF, Green Schoolyards), (g) outdoor areas for patient support groups and family recuperation (Walter Reed/Green Road). And professionals across the nursing, public health, physical rehabilitation, and landscape design sectors continue to experiment with Nature Therapy – despite the lack of published medical research on the topic – because they are steadily identifying connections that prevent and heal illness, promote health, and enrich people's lives (Frumkin, 2013) (Fisher et al., 2021) (Bratman et al., n.d.).

The National Recreation and Parks Association published a summary of research on this topic (*Mingkuo-Summary.Pdf*, n.d.) that included this statement:

> …do 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. Yes, we still find these benefits when we measure them objectively; yes, we still find these benefits when non-nature lovers are included in our studies; and yes, we still find these benefits even when income and other factors that could explain a nature-health link are taken into account. 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." (published in *Parks and Other Green Environments: Essential Components of a Healthy Human Habitat, NRPA (2010)).*

THE THIRD WICKED PROBLEM

Despite the potential for highly effective nature-based responses to the first two problems, the third wicked problem is deeply entrenched at two levels:

THE CONCEPT-PARADIGM PROBLEM

The healthcare sector responds to chronic disease with either (i) public health advocacy for lifestyle improvements to nutrition, sleep, and exercise or (ii) western medical interventions like pharmaceuticals or surgery. Climate resilience efforts focus on responses like cooling centers and access to air conditioning or water in extreme heat, clean water compliance, flood and disaster preparedness, and warning people to remain indoors during bouts of low air quality. And ecosystem degradation responses generally focus on large-scale, ex-urban wilderness protection strategies. These responses are all legitimate and important, but none works with nature in cities to create new *social and environmental systems* that rebuild and strengthen our local environments and population health simultaneously – in fact, they often further destroy natural systems and emit more greenhouse gases into the air. These responses are often a result

of emergency response or an intense focus on siloed solutions rather than rethinking how to adapt our existing systems and entrenched thinking to a changing world.

THE INSTITUTIONAL-OPERATIONAL PROBLEMS

Multiple self-reinforcing feedback loops then occur at institutional and operational levels as a result of the concept-paradigm problem (which also reinforce the concept-paradigm problem): (i) researchers don't study nature-based responses (or the most important features or implementation procedures to maximize health and ecological outcomes); (ii) lack of evidence of substantial dual-benefits (acceptable to medical experts and ecosystem scientists) has led to a lack of interest in NT as a treatment method and a lack of funding for its use (Wood, 2017); (iii) professionals in the healthcare sector have either never heard of NT or have numerous misconceptions about what it is, its effectiveness, and its implementation costs (all of which lead to profound skepticism of NT as a legitimate medical treatment or preventative option) (personal communications with HC1, HC2, and D); (iv) as nature presence and nature connections disappear from growing urban populations, nature's therapeutic effects on those populations diminish (Bratman et al., 2019).

As a result, funding for ecologically-restorative urban nature is left to the public and nonprofit sectors focused on parks, recreation and exercise, landscape architecture, and environmental protection – almost all of whom: have insufficient funds to implement their own goals or health-focused NT effectively; lack the capacity to optimize environmental and health outcomes simultaneously; and are unable to collect medically acceptable data on therapeutic effectiveness (Wood, 2017; (HealthPayerIntelligence, 2021). When practitioners do engage in NT, they face substantial obstacles in setting and measuring ecological restoration or health target outcomes that are persuasive to potential corporate funders. (HealthPayerIntelligence, 2021)

Moreover, to the extent NT advocates suggest nature-based solutions to healthcare problems, they often fail to ensure their proposed solutions maximize both ecological and health needs simultaneously because their missions are not aligned. And because organizations promoting cost-effective health responses and those promoting ecological restoration do not have fully aligned missions, the two sectors do not pursue a unified response.

SIGNIFICANCE OF THE PROBLEMS

Wicked Problem #1: Cardiovascular disease affects 1 in 3, or more than 83 million people, and heart attack and stroke are the first and third leading causes of death in the United States.[1] More than one third of the population is overweight or obese. Obesity is associated with increases in mortality rates and risk for widespread chronic illnesses, including type 2 diabetes, hypertension, high cholesterol, heart disease, stroke, respiratory illnesses, and some cancers. More than 60 million Americans have hypertension and high cholesterol, much of which is uncontrolled. Mental illness is also prevalent, affecting 25% of all U.S. adults, and can adversely affect the outcomes of other chronic illnesses. Lifestyle modification with medical

[1] 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*, n.d.)

management, diet, physical activity, and behavior therapy, including stress management, are recommended for the control of these conditions. (*Adult Health and Nature Fact Sheet*, n.d.)

In Maryland, chronic diseases such as heart disease, diabetes, and hypertension are the leading cause of death, disability, and healthcare costs. In 2007, Medicaid alone spent over $550 million dollars on chronic diseases. Approximately $196.3 Million was spent on hypertension alone, followed by diabetes at $157 Million. (*The Burden of Chronic Disease in Maryland | University of Maryland School of Medicine*, n.d.)

Wicked Problem #2: Meanwhile, in 2021, there were 20 weather/climate disaster events with losses exceeding $1 billion each to affect the United States; since 1980, the U.S. has sustained 323 weather and climate disasters where overall damages/costs reached or exceeded $1 billion. The total cost of these 323 events exceeds $2.195 trillion (Smith, 2020) Now, the environmental/climate risk sectors, both public and private, are spending (or will spend) billions, or possibly trillions, of dollars to address these and other related environmental problems, often while failing to explore cheaper and multi-beneficial nature-based responses (*A ROADMAP TO BUILD A CLIMATE-RESILIENT ECONOMY*, n.d.) (*Trillions Are Being Committed to Climate Mitigation, but What about Climate Adaptation?*, n.d.) (*Hunting for Money*, n.d.) (Pralle, 2019).

Wicked Problem #3: By neglecting nature-based solutions, we are missing opportunities to create efficiencies and magnify impact. At the same time, there are insufficient funding sources -- in both the environment and healthcare sectors – to adequately address either set of problems separately. And, although beyond the scope of this paper, the lack of funds has a disproportionately negative impact on poor and disenfranchised communities. Yet, if we combine funding and align success metrics for public health/social determinants, ecosystem restoration, and medical treatment, we can scale combined solutions for regional impact.

RESEARCH QUESTIONS

1. Partnering with Nature: What kinds of nature experiences work as "nature therapies"? What do these "nature therapies" (NT) look like in practice or research studies?
2. How does NT affect the body? Given changes in body, which diseases should be most susceptible (based on current knowledge) to treatment or prevention with NT?
3. What are the key characteristics that make NT most effective? (Spatial-Temporal-Experiential); can we implement them in urban areas and what other constraints must we consider?
4. What would the optimal solution look like? (And does it require private sector participation and funding?)
5. What entities in the healthcare sector have the greatest financial incentive to take action to reduce costs of conventional therapies without sacrificing health outcomes?
6. How much (in dollars) would the optimal solution have to save in healthcare expenditures to make the solution financially feasible for corporate healthcare payers to implement it? And is it viable?
7. How big of a financial return on this solution might there be?

URBAN HEALTH FORESTS AS THE UNIFIED RESPONSE

This MP explores whether it would be financially feasible to refine the principles of NT in use today and incorporate them into spaces and practices that would regenerate nature in urban settings for the specific purposes of addressing chronic disease and ecosystem degradation. After exploring what therapeutic nature practices have been used and studied, I propose that growing a distributed network of urban "Health Forests" (native forest patches that are intentionally regenerated, designed, and operated to maximize ecosystem health and human health benefits) can start to reverse the wicked problems. By consciously working with nature to achieve ambitious ecological and health treatment measures, we can help the environment and people more cost-effectively than we do today *and attract new sources of funding while we do it*. This MP examines whether – and under what circumstances – investing in a widespread network of urban Health Forests can lead directly to a reduction in health expenditures for cardiovascular (and other chronic) diseases while reversing ecosystem degradation and responding to climate change.

ROADMAP

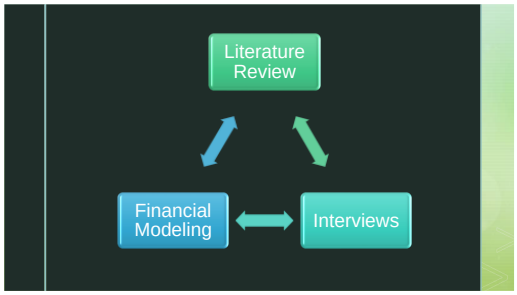
This MP is presented in four parts. The following section on Methods presents a detailed review of the process and methods I used to arrive at my research findings. It includes a discussion of the iterative approach I used to proceed with literature review, interview preparation and interviews, my construction of a set of assumptions necessary to run a simple financial model, and the construction of the financial model itself, which quantifies the potential financial benefits to private healthcare payers were they to invest in Health forests." Following Methods, the Results/Findings section will present my findings based on the mix of research methods I used. Within Results/Findings, I will first discuss how NT is used and understood to work, what health benefits practitioners have observed, features of NT that appear to optimize health and environmental outcomes, what the optimal NT solution might look like (i.e., Health Forests), and how key features of Health Forests inform the assumptions in the financial model. Finally, I will examine which entities might have an incentive to implement Health Forests and review the potential financial returns of investing in Health Forests, and whether current circumstances make this option viable. In the Discussion section, I will revisit my investigative questions to reach prescriptive recommendations for healthcare payers, policy-makers, and NT providers. Within the Discussion section, I will examine the implications of my findings for using a market-based strategy to increase health and environmental impact, as well as the gaps in the literature that must be filled to create a more robust financial model and better medical treatment decisions. In the Conclusion, I will present the practical implications of this research and suggest topics for future research. Despite this organization, subjects presented in each section relate to – and depend upon -- one another and may appear in different contexts.

METHODS

OVERVIEW OF RESEARCH DESIGN

My research consisted of three main components designed to answer the above research questions:

(i) literature review,
(ii) interviews with professionals and practitioners working in either nature therapies or patient health/the healthcare sector, and
(iii) constructing a simple investment model that incorporates projected costs and revenues estimated from the MP research.



The iterative process that caused my methodology to evolve in non-linear directions over the course of my research is described below.

STUDY AREA DESCRIPTION

Geographic Focus Area: metropolitan statistical (e.g., urban) areas of the mid-Atlantic region of the United States (due to forest habitat and high concentrations of people), as well as income disparities that take spatial form. For information about the importance of urban forests to both the environment and public health in these locations, see https://www.nrs.fs.fed.us/urban/sustainability/urban-forest-patch-silviculture/). I note, however, much of the available data for the MP is from west coast/pacific northwest.

Sector/Healthcare Focus: MP focuses on synchronizing the core interests of private healthcare payers (who are focused on cost-savings/population level disease prevention and lowering cost of care) with core environmental restoration and population health needs. Secondary target audience of MP is nonprofits, foundations, researchers, and medical professionals trying to optimize, fund, or implement cost-effective outdoor programming focused on improving health outcomes.

DATA COLLECTION: PROCEDURES AND METHODOLOGY

DATA COLLECTION PROCEDURE

- Initial literature review to assess state of conversation on health and nature
- A series of interviews with people practicing in the fields of NT
- Further literature review on kinds and effectiveness of nature therapies
- Literature review on optimal kinds of NT and how to maximize NT effectiveness
- Literature review on healthcare costs and entities that finance healthcare costs
- Interviews with people working in population/public health, improving health outcomes, and advising healthcare payers about innovations in healthcare and cost efficiencies
- Develop financial model to assess net cost savings from using NT

- Additional literature reviews on costs and industry metrics; discussions with professional contacts to address gaps in published knowledge.[2]

CHOICE OF METHODS: LITERATURE REVIEW, INTERVIEWS, MODELING

Literature Review. Literature review was essential because I (i) needed to establish what is currently known about the topic, (ii) needed to access publicly accepted healthcare cost estimates, (iii) determined that healthcare payers (whether hospitals or insurance companies) will not change their decision-making without peer-reviewed medical studies that show a treatment's effectiveness.

Interviews. I chose to interview (i) one group of people in the NT practice and research arenas and (ii) another group of people working in the healthcare industry who focus on improving patient outcomes and the cost-effectiveness of various treatments, who could potentially implement a health-forest vision, and who work with/advise healthcare payers (and know how they make decisions). The interviews were semi-structured and attempted to elicit a wide range of information and to guide my literature reviews in the most useful directions. I developed interview guides with predetermined questions – one set of questions designed for health industry professionals and one set of questions for people involved in nature programming or study. Certain questions overlapped. Interview protocols are attached as Exhibits 2 and 3. The interviews were essential for filling in gaps in the academic literature – since so much information about NT is anecdotal and contained only in the experiences of local practitioners.

Both kinds of data collection (literature review and interviews) were necessary: (i) each to inform the other, and (ii) to obtain rough estimates for the assumptions underlying the financial model. There is not enough publicly available data to formulate the financial data without both methods.

Note: In some cases, I obtained specific cost data through professional contacts with experience working in the area, though they were not structured as formal interviews.

Financial Model. If private, third-party healthcare payers have the greatest incentive to invest in nature-based healthcare treatments, they must have a financial justification to do so. Based on my research, there is a need for a market-based strategy, yet no one has yet tried to quantify the potential returns on investment from using nature therapies to treat diseases (Fisher et al., 2021). Analysis is necessary to assess, using hypothetical dollar figures, whether there is a financial justification for healthcare payers to pay to create and implement targeted NT.

Although the dollar estimates in the financial model are gross estimates, often extrapolated from other cost contexts, a framework for quantitative analysis is essential for attracting private healthcare payers into this new area of health/nature intersections. These "back of the envelope" calculations help determine a gross range of expected investment returns to determine whether the investment is feasible.

Many of the individual decision makers in corporate healthcare payers are unfamiliar with real estate, habitat/forest regeneration, or nature therapies: they have no idea what the likely costs of creating Health Forests are – and therefore, no idea how those costs compare to conventional treatment costs (Personal

[2] All literature review involved only English-language publications and concluded with publications published prior to October 2021 (except to the extent online medical statistics were accessed through January 2022).

communications with HC1, HC2, D, and ICE). Furthermore, most people who study or perform NT do not know the estimated costs of creating a "permanent home" for their therapeutic activities, what diseases their activities might specifically target, or what the conventional costs of treating comparable target diseases are. Many NT practitioners either have not considered or are unable to quantify the health benefits of their activities in terms of avoided conventional healthcare costs (Fisher et al., 2021) (Personal communications with P3; (Wood, 2017). Often nature therapies are treated more as vacations, school recess (in the case of children), outdoor learning classrooms, or "work breaks" rather than health interventions, and therefore are not studied or run as a health intervention that intentionally follows evolving research on best practices in NT.

ITERATIVE DATA COLLECTION PROCESS AND ANALYSIS

My different data collection methods informed each other over the research period.

I began the research process with conversations with the staff of the Health & Outdoors Initiative at the Willamette Partnership, a nonprofit organization in Oregon that promotes nature-based solutions and runs programming that builds nature-health connections. After speaking with them, I moved to a review of their numerous publications on green infrastructure, nature, and health written with collaborative teams (e.g., Green Infrastructure & Health Guide, July 2018; Green Infrastructure and Health Policy Scan, July 2019; (*Greener Parks for Health, Green Infrastructure, Conservation | National Recreation and Park Association*, n.d.). Moving from that introduction to the topic, I began a literature search.

FIRST FOCUS: LITERATURE REVIEW OF NATURE THERAPIES

To address the first set of research questions, my literature review examined:

(i) the existing range of nature therapies and the kinds of programs and events that use nature to promote public health or medical treatment;
(ii) how nature experiences can affect the body and which diseases are most responsive to nature therapies; and
(iii) what characteristics of nature settings correlate with consistently demonstrated health outcomes.

Primary research databases I relied on I found in Duke Library: Web of Science, Scopus, PubMed and general library search. I also used Google and Google Scholar search engines. My Search Terms (broad search) included: nature, health, nature and treatment, nature therapy, physical effects of nature, forests and health, forest-bathing, healing gardens. Research of peer-reviewed academic research (including medical literature) revealed a surprising number of positive effects on the body and a range of diseases that could be treated or prevented by nature therapies.

Beyond academic peer-reviewed papers, I found many publications about the effects of parks on health and well-being and the successes/effects of outdoor classrooms. These were largely published by NPS (healthy parks, healthy people), USFS, NRPA, and other park or nature NGOs (Willamette Partnership (see above), The Nature Conservancy, the National Forest Foundation, NEEF). A number of newspapers and popular magazines have also covered this phenomenon, like The Atlantic (Alter, 2013). I also reviewed two prior Duke University (NSOE) MEM Masters Projects related to this topic (Wood, 2017; Sammis, 2020).

GAPS IN LITERATURE REVIEW THAT INSPIRED NATURE-FOCUSED INTERVIEW GUIDE

This area of study falls within the intersection of public health, population health, diagnosed diseases, healthcare reimbursement systems, landscape design, urban planning, outdoor and public education, psychology and social work, and healthcare programming for rehabilitation and prevention. Very few studies or publications examine these numerous intersections collectively or in any kind of systematic way. My literature review revealed numerous gaps in the data that informed my interviews; those gaps included:

- Medical Perspective. Since the majority of literature on NT is not medical research (or peer-reviewed), the literature had substantial gaps, including (i) measuring objective physiological effects of nature experience on the body; (ii) studying the responses of particular diseases across different demographic/cultural groups within consistent nature contexts; (ii) studying the response of particular diseases in specific U.S. populations across nature contexts; and (iii) studying nature effects on human physiology over time. Some of literature did not define "nature" or "green space" in reporting particular health effects. The bulk of studies focused on mental health, and, often used self-reported measures (Wood, 2017). Most research has yet to identify clear causal relationships, in part, because very few experiments or observational studies take place in contexts where researchers can isolate the effects of health-nature interactions (Frumkin, 2013).

- Cost/Investment Perspective. I could not locate any studies that analyzed the potential financial return to private healthcare payers of investing in nature therapies as substitutes for conventional medical treatments. While findings on the health effects of immersion in nature on the human body are emerging, none have examined the potential cost savings to private healthcare payers of using nature therapy.

- Ecosystem Perspective. I could not find health-nature studies that intentionally considered what kinds of therapeutic nature might do the most to strengthen the local ecosystem surrounding the healing space. Rarely do people design therapeutic nature setting with the dual priority of finding the replicating/complementing surrounding or (or pre-development) native habitat and using local ecotypes or regenerating local, healthy soils.

These gaps in the research led me to a set of interviews with practitioners and researchers in the field of nature therapies (though not all of them prefer to refer to their work as nature therapy).

FIRST ROUND INTERVIEWS – NATURE THERAPIES

I then sought out interviewees who could help me identify the physiological and psychological pathways to health that nature triggers. I also looked for people who understood key barriers to combining natural restoration and healthcare treatments – particularly treatments targeted at treating people where they live and addressing social determinants of high-cost diseases. Interviews also helped me narrow down and define the search and scope of study. Interviewees not only provided some answers to my questions based on their own experiences, but they also pointed me toward research and writings that guided their work.

I identified my interviewees largely through personal and professional contacts, and then used the "snowball" method to identify additional professionals with insights into this topic. Interviews were arranged via email and scheduled for 1 hour.

INTERVIEWEES – NATURE THERAPY ORIENTATION

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)	Nonprofit – 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

SECOND FOCUS: MEDICAL AND HEALTHCARE LITERATURE REVIEW

My literature review on healthcare focused on:

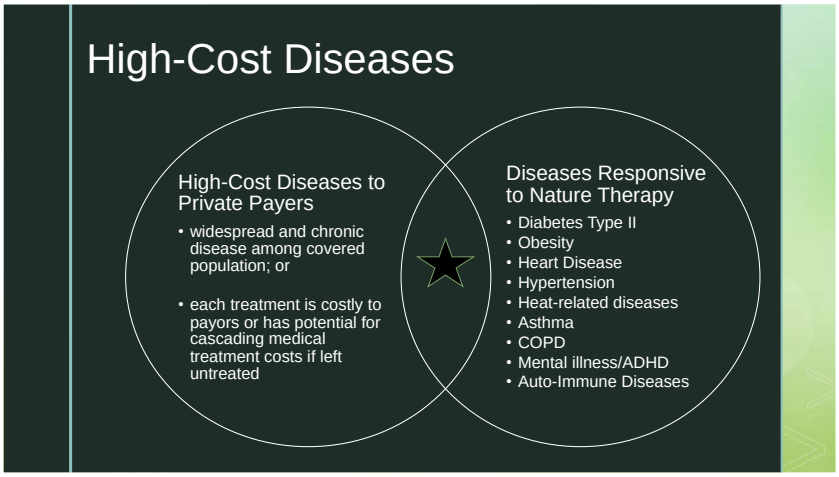
(i) which corporate healthcare payers have financial incentives to reduce treatment costs while maintaining optimal health outcomes, and, for those with a financial incentive, why they are not investing in nature therapies already;
(ii) which diseases cause the largest healthcare expenditures by private healthcare payers (and which of those diseases could likely be treated with nature therapies); and
(iii) what is the potential financial return of an optimized nature-based health treatment response that could defray some of the largest expenditures of private payers, and is it viable?

After I assembled a list of highly prevalent urban diseases that NT has treated (or could potentially treat or prevent), I began a second literature review to identify which of those diseases cost the most for private healthcare payers. I researched academic journals and government/healthcare industry websites and publications to identify the highest cost diseases in the U.S., who pays for them, and the size/kind of expenditures private healthcare payers spend for standard treatments for those diseases. For example, the largest portion of direct medical spending on heart disease in 2017 was for inpatient hospital care (at 54.8% of spending) (*STATISTICAL BRIEF #531: Healthcare Expenditures for Heart Disease among Adults Age 18 and Older in the U.S. Civilian Noninstitutionalized Population, 2017*, n.d.), and heart disease was at the top of the costliest diseases in the United States for healthcare payers in 2020 (Kirkland et al., n.d.).

In my online searches, I used the following databases from the Duke Libraries: Web of Science, Scopus, PubMed. I also used Google and Google Scholar search engines. My most common search terms were: health care, healthcare costs, healthcare expenditures, most costly diseases, costs of heart disease, costs of cardiovascular disease, most expensive diseases in the United States.

I compared the list of "high cost" diseases and treatments with the list of diseases likely to respond to NT either as prevention or treatment, and I also considered what kinds of nature therapies could produce the best outcomes for satisfying the dual goals of the MP. Although I tried to get data on what kinds of expensive treatments were most likely to occur (and how often) within the highest cost disease categories, this level of granularity was difficult to obtain or use meaningfully in the financial model.

Then I focused on diseases in the overlap between the two. To compare different sized groups of patients in the financial model, I needed the average cost per patient, which would also allow a sensitivity analysis on the financial benefits of treating different sized groups of patients in particular nature therapy sessions.



GAPS IN LITERATURE REVIEW THAT INSPIRED HEALTHCARE-FOCUSED INTERVIEW GUIDE

Gaps in the research data included: (i) which corporate healthcare payers had the greatest incentives to reduce expenditures for particular diseases and what those incentives were; (ii) why healthcare payers are not investing in nature-based health responses to high-expenditure diseases; (iii) which high-expenditure diseases were of greatest concern to private payers and why; and (iv) what size of financial return could incentivize private corporate payers to invest in nature therapies.

SECOND ROUND INTERVIEWS – HEALTH CARE

In the second round of interviews, I spoke with healthcare consultants, a doctor in a large hospital, and one insurance company employee. Discussions included: which healthcare payers have the greatest incentives to reduce healthcare costs while maintaining or improving patient outcomes; which diseases require the largest healthcare payer expenditures and why; and payer concerns with nature therapy programs and neighborhood-based treatments. Although I attempted to identify a threshold ROI, IRR, or required rate of return, no interviewee was able to provide one (or even a basic range of what is normally required).

INTERVIEWEES – HEALTHCARE DELIVERY ORIENTATION

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) (*note: no permission to quote)	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

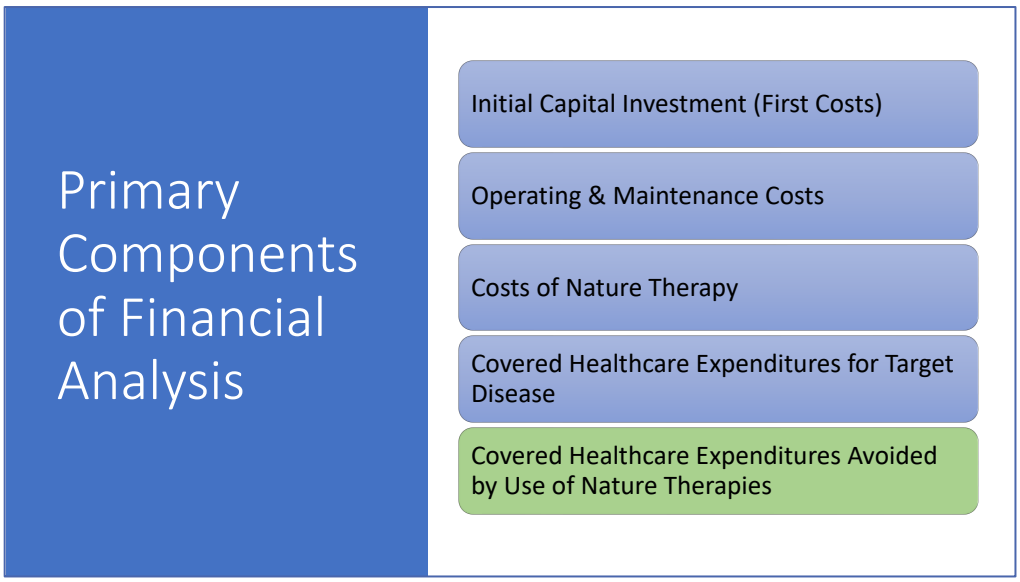
THE FINANCIAL MODEL – CALCULATIONS AND DOLLAR COST ASSUMPTIONS

Neither the literature reviews nor the interviews could address the question of what the potential financial return on an optimized nature-based solution might be or whether such a solution could be viable. Therefore, the financial analysis was essential. For this analysis, I built out a financial model like a simple real estate acquisition/investment pro forma that can estimate predicted financial returns to the investor based on a set of assumptions about the project, cash outflows, and cash inflows. The model estimates the costs of creating and operating an optimized nature-based treatment (determined based on nature-related data and findings) and then determines the net present value of the cost savings that the nature-based treatment could generate for private healthcare payers.

More specifically, the financial model examines the financial effects of replacing certain conventional CVD treatments (and their associated expenditures) with NT treatments, and avoided costs are treated as revenues to the healthcare payer.

PRIMARY COMPONENTS OF FINANCIAL ANALYSIS

To model the financial implications of using nature therapies in lieu of conventional treatments and preventive care, I used the following model components:



1. *Initial Capital Investment* includes costs of:
    a. Land acquisition (assuming raw land or land with small structure),
    b. "Build out": forest regeneration, design, and installation of health program features,

c. Possible demolition or reuse of small existing structures[3]

Note: The model assumes that all initial capital expenditures (outside of routine maintenance) are invested in Year 0 -- and that acquisition and regeneration can occur sufficiently to conduct NT after 1 year. (Dollar figures were converted into per sf costs and then incorporated into ½ acre parcel scenario)

2. *Operating and Maintenance*[4] (beginning in first year of operations) includes costs of:
   a. Maintenance for healthy forest growth, safe pathways, and stewardship of structures and signage;
   b. All utility, insurance, and property taxes. Costs of property security systems are not included in current model (due to lack of information); however, such costs can be deemed covered in sensitivity analysis testing for increased O&M costs.

Operating and maintenance expenses are assumed to escalate at 3% per year. Note: costs of operating NT Programs 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 therapy programs.

3. Cost of Nature Therapy Programming. Cost of operating Nature Therapy programs is essentially the cost of nature therapists who are sufficiently trained (or certified) to lead patient groups in NT. Given the nascent state of the NT market, there is not a well-established rate of payment for NT practitioners, so I relied on the rate used for horticulture therapies at Legacy Rehabilitation Institute of Oregon (RIO) at Legacy Good Samaritan Medical Center. The model assumes that the healthcare payer pays the full cost of the NT – and based on this assumption, the model also assumes all NT sessions are fully subscribed by the first year of operations.

4. Costs of Conventional CVD treatment. Average medical expenditures for individuals with (or at high risk for) cardiovascular disease. In the model, that per-person average is calculated for the hypothetical treatment group. Cost data for expenditures connected with CVD were retrieved from MEPS and categorized as "heart disease." (See Exhibit 4 for more information.)

5. Covered Healthcare Expenditures Avoided by Use of NT (i.e., Cost Savings/Revenues). The model creates a variety of scenarios that show what would happen if NT can reduce certain percentages of conventional covered expenditures for CVD. Assuming those savings represent "revenues" (in terms of avoided costs) to the investor/healthcare payer, the model subtracts from those savings the costs of Nature Therapy Programming to arrive at the dollar value of net avoided healthcare expenditures. These "revenues" are then calculated in terms of net present value and IRR is determined based on the initial investment cost.

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[3] I did not have reliable figures on demolition costs (which might be necessary for structures on the land), so I did not include demolition costs in the Capital Investment estimate. Also, all real estate investments have property-specific costs and additional costs, like remediation or regrading, which could be necessary. Sensitivity analysis looks at how increases in initial investment costs would affect the outcome.

[4] Note: O&M costs will vary with property location, decisions about maturity and design of initial installation (the model assumes these decisions are made to reduce long-term maintenance costs), property size, and insurance carrier.

FOCUS ON CARDIOVASCULAR DISEASE (CVD)

Although academic studies showed nature therapy effectiveness in treating several different high-cost diseases, it became clear that studying the costs and effects of NT on too many different kinds of diseases would be unwieldy, given that research was not consistent across disease types nor is current NT programming targeting specific range of diseases studied in academic research.

I chose CVD because (i) it is one of the costliest disease categories in the United States (including to third-party payers) – due to both cost of individual treatments and prevalence across population, (ii) it is preventable and responsive to NT, and (iii) CVD causes, treatments, prevention, and expenditures are all well-researched and documented with respect to traditional western medical treatment and in connection with nature-based treatments.

- In 2017, 1 out of every 12 adults aged 18 and older had healthcare expenditures for the treatment of heart disease
- Annual healthcare expenditures for the treatment of heart disease for adults in the civilian noninstitutionalized population totaled $108.7 billion in 2017 (with a mean of $5,216 per adult with any heart disease expense) – approximately 7% of total annual healthcare expenditures

Citation: (*STATISTICAL BRIEF #531: Healthcare Expenditures for Heart Disease among Adults Age 18 and Older in the U.S. Civilian Noninstitutionalized Population, 2017*, n.d.-b).

FORESTS AS THE FINANCIAL MODEL'S "NATURE" SETTING

I decided that this MP (and the financial model) should focus on forests as the nature setting to model for the reasons set forth in Finding #4. In summary, forests provided the best nature context for the model because (i) forests offer most (or all) of the natural features that are important for NT, (ii) they are the most studied nature setting, and (iii) they are the native habitat of the mid-Atlantic piedmont areas, which is the geographic focus of the MP. See Results and Discussion sections for further elaboration on the specific importance of forests as the nature setting for Health Forests.

NUMERICAL INPUTS TO MODEL

The key cost assumptions used for the financial model, and supporting sources, are set forth on Exhibit 4.

ADDITIONAL SOURCES OF DATA

Developing the financial model also provided a key framework for the kinds of cost information required for this investment analysis. Often, as I built out the model, I realized I needed new or different data than what I had obtained through interviews or literature review, and these needs drove further efforts to collect data. In some cases, I sought out the perspectives of professional contacts working in the relevant fields.

MODEL OUTPUTS

The financial model focuses on the Net Present Value (and IRR) for an investor who pays to develop and use Health Forests to offset conventional CVD treatment costs under different cost scenarios. The model uses a discount rate of 10% and performs a sensitivity analysis on this number.

INPUTS AND ASSUMPTIONS TESTING: SENSITIVITY ANALYSIS

Particularly since many of the estimates used are imprecise and highly situation dependent, I performed a sensitivity analysis on key cost assumptions. Model tests:

- ⇒ Higher than anticipated costs of NT
- ⇒ Lower than anticipated costs of conventional therapy
- ⇒ Lower percentage of conventional costs avoided (this is addressed with 3 different baseline cost avoidance scenarios, and then tested sensitivity on each scenario)
- ⇒ Higher than anticipated O&M costs
- ⇒ Higher than anticipated capital investment costs (i.e., first costs)
- ⇒ Sensitivity modelling also examined changes in treatment costs and O&M costs under a declining discount rate scenario

MAJOR LIMITATIONS OF DATA AND ASSUMPTIONS

1. Terminology – there is no accepted lexicon for nature-health connections, what constitutes nature, or how to label the health effects of nature on people. See Glossary for this MP's use of the term NT.

2. Data on effectiveness of NT – very few peer-reviewed studies on this issue for any diseases, including CVD. Bulk of research focuses on general health, well-being, and emotional experience. However, data from Japan and other foreign countries contains more rigorous metrics, but sample sizes are small. No peer reviewed studies examine the role of group size in NT as a variable in patient health outcomes – or whether there are maximum group sizes before therapy effectiveness wanes.

3. Amount of Avoided Healthcare Expenditures for CVD – healthcare costs are often measured either (i) at the individual level for very specific diseases that occur under specific circumstances, or (ii) at the national population level for broad categories of diseases (e.g., "cardiovascular diseases" vs. "coronary heart disease"). Because cost data is not available at sufficiently granular levels to isolate the costs of specific subsets of CVD relevant to this analysis (and because of Limitation #4 immediately below), an attempt to compare conventional healthcare expenditures for specific diagnoses with the cost of NT for those same diagnoses would be highly speculative at best. Instead, I used population-level estimates for the healthcare costs of "cardiovascular diseases" – which is a larger category than the set of cardiovascular diseases that can be treated or avoided with NT. However, this overestimation is mitigated by the underestimation caused by limiting the cost analysis to CVD only, given that NT appears to have significant effects on CVD risk factors and co-morbid diseases like diabetes.

4. Specific Cardiovascular Diseases that can be avoided with NT – because research studies have not examined which insurance procedure/diagnosis codes, as defined by U.S. insurance companies, or which specific diseases, as categorized by MEPS (Medical Expenditure Panel Survey), within the CVD category could be reduced or avoided with NT, it is difficult to model specific cost savings attributable to NT by diagnosis/procedure code. For reasons listed in Limitations #3 and #4, the financial analysis uses incremental reductions as a proxy – assuming 40%, 30%, 20% and 15% cost savings scenarios.

5. Costs attributable to private healthcare payers – 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. Anecdotally, a professional in the insurance industry indicated that % 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 % coverage is higher (D. Lloyd, personal communication, February 19, 2022). There was no publicly available information suggesting there might be insurance coverage for non-traditional therapies like nature therapies, so estimating the percentage of this coverage was necessarily hypothetical.

6. Number of people treated by NT – the number of people treated by NT depends a few embedded assumptions: (i) the space could be used 6 days/week all year round; (ii) the NT program would be fully subscribed from the first day; and (iii) that 20 people (in 1 group) in the space for 1 hour of programming is the optimal number of people (see Exhibit 4). Because the model compares "per patient" expenditures – whether for NT or conventional treatment – if the number of people were to change, the delta in healthcare expenditures should remain constant. However, the initial capital investment and O&M costs will not vary by number of people treated (so the fewer people treated, the total net cost savings will shrink relative to those fixed costs and vice versa).

7. Period of Time to Regenerate Forest Patch – the model assumes that a forest patch can be regenerated to the point where it can function as Health Forest within 1 year. While it will not be possible to achieve a mature forest or enclosed canopy within 1 year, the model assumes that relatively mature – or fast growing – trees can be planted to create sufficient abundance to perform successful nature therapy after 1 year.

8. Discount rate – in the current real estate market, a 10% discount rate is conservative (i.e., high) based on the prevailing weighted average costs of capital (WACC). However, while 10% is a conservative given WACC, including debt. It is possible, however, that, when using solely equity (which may be necessary for early Health Forests), the required rate of return should be higher (12-15%) (F. Greene III, personal communication, February 5, 2022). Therefore, the sensitivity analysis tests the financial results with a 15% discount rate, which did not materially change the outcomes except on the margins.

ETHICAL CONSIDERATIONS

Before proceeding with recorded interviews, I applied to the IRB for a human subject experiment exemption. The exemption was provided subject to IRB # Protocol: 2021-0535. I have no relationship or financial interest in the subject matter or with any of the interviewees. For certain data, I reached out to professional contacts to obtain current, industry specific information that was not publicly available.

RESULTS/FINDINGS

SUMMARY FINDINGS

I explored whether people could create and operate a nature therapy specifically designed to optimize health and environmental outcomes that could do more (than current baseline) to help the environment, help people, provide a new source of funding for conservation, and deliver financial returns on investment to healthcare payers who fund these projects. I examined whether healthcare payers would benefit

financially if they invest in a specific nature therapy that I call "Health Forests" which would be intentionally created and distributed across urban neighborhoods with a high prevalence of high-cost, chronic diseases. Specifically, could Health Forests generate substantial healthcare expenditure savings, despite the need to invest in land purchases, forest regeneration, and healthcare programming?

The results suggest that the answer is yes. If designed and programmed effectively, urban health forests distributed across residential or mixed-use neighborhoods – especially in areas with medium to low land values and a high prevalence of cardiovascular disease (or cardiovascular disease risk factors and co-morbidities) – could have substantial economic benefits for healthcare payers without sacrificing positive patient outcomes and while providing both climate mitigation and adaptation (e.g., flood management, heat island reductions, air quality improvement) benefits.

IN-DEPTH FINDINGS

FINDING #1: NT APPEARS IN A WIDE-RANGE OF FORMS AND PROGRAMS (EXAMPLES)

WHAT IS NATURE THERAPY?

Currently, there is no consensus among academics, researchers, or practitioners about what constitutes "Nature Therapy," and some practitioners would adamantly state that what they do is not it. For this MP, I refer to the collection of activities in which humans experience connections to nature for therapeutic purposes, as "Nature Therapy" (or NT). That is, to fully examine the possibility of a nature-based health and environmental response to the three wicked problems, I include as NT all forms of planned or intentional human-nature connections for promoting health, including Forest Bathing, Shinrin Yoku, Horticultural Rehabilitation, Outdoor Education, wilderness experiences (including hiking, camping, rock-climbing, biking), visits to local parks, and other human-nature activities. Below, I review examples of NT, and the characteristics that make them successful, in depth.

EXAMPLES OF THE RANGE OF NATURE THERAPY

Outdoor Excursions for People Who Have Suffered Physical Trauma/Disability (Willamette Partnership)

Accessible Camping Trips: WP works with CBOs to take individuals who have suffered physical traumas out camping in the wilderness. This is 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.

Green Schoolyards/Outdoor Classrooms/Outdoor Preschool (Willamette Partnership)

The Willamette Partnership promotes the use of outdoor classrooms (see Outdoor Preschool Policy Action Toolkit), particularly among pre-school aged children.

Biodiversity Intervention at Urban Daycare Centers (Roslund et al.)

Roslund et al. conducted research on the biodiversity hypothesis using nature therapies. Treatment groups attended (i) urban day care centers where their yards were covered with forest floor and sod, or (ii) nature-oriented day care centers where children visited nearby forests on a daily basis (Roslund et al., 2020; Roslund et al., 2021)

Association of Nature and Forest Therapy Guides and Programs – Forest Therapy/Forest Bathing

Forest therapy is not a random walk in the park. According to the Association of Nature & Forest Therapy Guides and Programs, 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…." https://www.natureandforesttherapy.earth/about/the-practice-of-forest-therapy

Healing/Rehabilitation Gardens and Nature Paths (Hospitals)

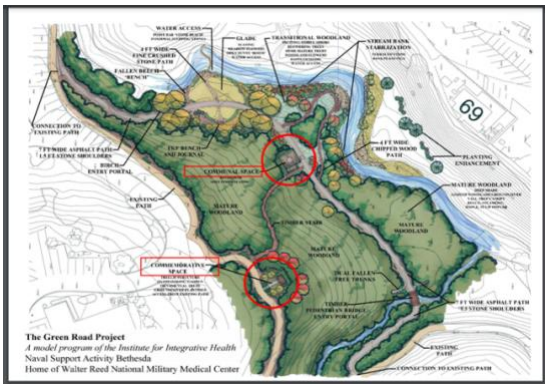
Views of healing/therapy gardens at different hospitals are shown here:

1. Hospital Healing Gardens, Chile ((*Healing Gardens: Nature as Therapy in Hospitals | ArchDaily*, n.d.)

https://www.archdaily.com/972112/healing-gardens-nature-as-therapy-in-hospitals

2. Hospital – Horticultural/Occupational Therapy Gardens – Legacy Health, Oregon (*Healing Gardens and Horticultural Therapy*, n.d.)

3. Walter Reed Naval Hospital – Green Road Project: Nature experience for wounded soldiers (*Green Road at Walter Reed National Military Medical Center*, n.d.)



EVOLVING STUDY OF NATURE THERAPY

Over the last two decades, research has revealed the profound therapeutic effects on the human body of certain kinds of nature experiences. "During the 1980s, Shinrin Yoku surfaced in Japan as a pivotal part of preventive health care and healing in Japanese medicine" (Hansen et al., 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 (Li, 2010) (Hansen et al., 2017). European researchers have recently expanded understandings of the multiple pathways through which nature protects and heals us (Roslund et al., 2021). And, recently, the field of nature-health intersections has entered the mainstream of public health conversations in the United States (*Medical Providers Are Taking Nature Therapy Seriously*, 2021). Yet much remains to be determined and measured about nature-health connections and their use as medical treatments.

FINDING #2: HOW NT AFFECTS THE BODY/KNOWN THERAPEUTIC EFFECTS

This question remains under examination, but existing practices and current research show the following:

MENTAL AND PHYSIOLOGICAL HEALTH EFFECTS OF NT

The following studies, compiled by Hansen et al., provide examples of NT effects (Hansen et al., 2017):

- ⇒ 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.
- ⇒ 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.
- ⇒ In 20 adult patients with coronary artery disease (CAD), cardiac function improved after a week of 30-minute sessions in nature.
- ⇒ 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.
- ⇒ In a longitudinal study of 48 adults diagnosed with Diabetes Mellitus II, blood glucose readings declined after multiple Shinrin Yoku practice sessions.

⇒ 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.

Additional examples are:

⇒ 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 (Donovan et al., 2019).

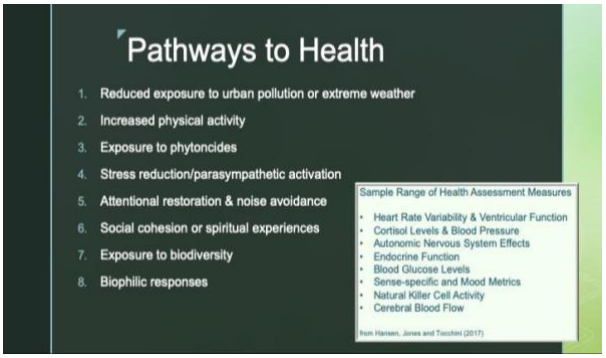
⇒ 12 men took a two-night trip to a forest in Nagano Prefecture in 2006, including three leisurely strolls and a hotel stay in the woods. 13 female nurses made a similar trip in 2007. Natural killer cell activity was boosted in both groups, and the increase was observed 30 days later. Increase in NK activity can be attributed partly to inhaling air containing phytoncides, or wood oils given off by plants. (*Forest Therapy, Forest Therapy Association of North America Forest Therapy*, n.d.)

⇒ 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, type 1 diabetes and auto-immune diseases (Roslund et al., 2020) (Roslund et al., 2021)

Based on my research, the diseases that appear to be most responsive to NT are chronic diseases such as cardiovascular disease, hypertension,[5] diabetes, mental illness (particularly depression and anxiety), attentional disorders (ADD and ADHD), and allergy avoidance in children.

PSYCHO-PHYSIOLOGICAL PATHWAYS OF NATURE'S EFFECT ON THE BODY

How do human-nature connections, or NT, achieve their beneficial effects on the body? The answer is not entirely clear. The pathways shown here reflect the scientifically supported hypotheses about the mechanisms underlying the nature-body connection (Wolf et al., 2020) (Frumkin, 2013) (Li, 2010) (Hartig et al., 2003) (Roslund et al., 2021).[6] Some of these pathways require programming or community effort to cultivate them (e.g., social cohesion must be



[5] Hypertension, which is a widespread disease in the United States, is usually distinguished from cardiovascular disease but is interconnected and often a precursor.

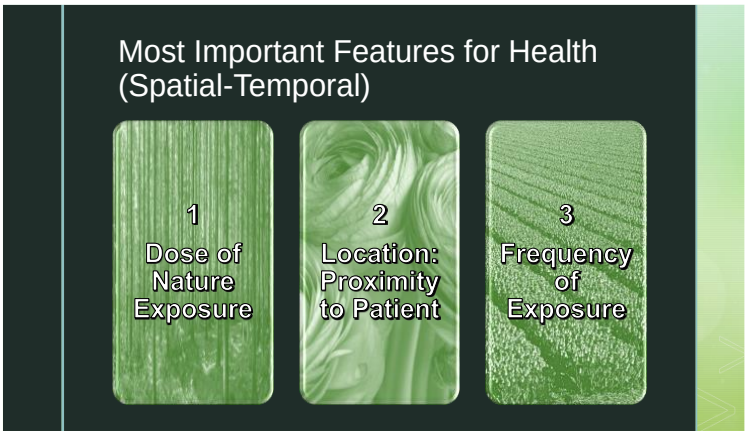
[6] Studies that hypothesize about the pathways and mechanisms by which nature has health effects on the body have been evolving in the United States since the 1980s, and different schools of thought have emerged, as scientific research has expanded. A comprehensive review of these hypotheses is beyond the scope of this paper. However, 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

cultivated in the space for it to affect individuals). Given the substantial range of effects on the body, there are likely additional pathways; 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 (*It's True*, n.d.; (Buxton et al., 2021; (Aerts et al., 2018)

FINDING #3: KEY DESIGN, SPATIAL, TEMPORAL, EXPERIENTIAL FEATURES FOR HEALTH

As described, Nature Therapy is an umbrella term for many kinds of nature-based practices. I wanted to distill out the key features of these practices that appear to be most likely to produce the optimal health outcome, and then see if we could incorporate those features into high-quality urban green spaces. Based on my literature review and interviews, I found that the 3 most important spatial-temporal features for optimal health outcomes are:

- First, 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);[7]
- Second, the geographic proximity to participants (i.e., the nature space must be physically close by and easy to access for the individual);
- Third, the frequency of exposure (i.e., how often a person returns to the nature space for exposure over time).



Note that these factors interact: so, a very small dose of nature exposure might require increased frequency to maintain a health effect. However, these relationships have not yet been quantified.

A fourth set of features – related to an individual's subjective experience – must also be addressed to maximize the health effect of the space. These factors are reviewed below in subsection D.

A. NATURE EXPOSURE – DOSE: DESIGN/SETTING/DURATION

Dose: What kind of nature type, context, and exposure have the most significant health effects?

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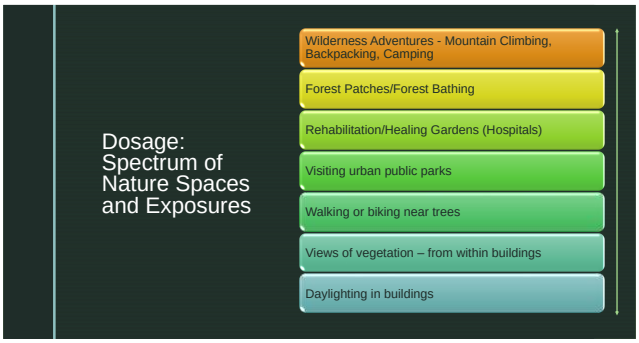
that these interactions promote healthy balance in the immune system and long-term protection from allergies and inflammatory disorders (Haahtela et al., 2021).

[7] I note that different research studies define "dose" differently: Shanahan, et al. use the terms "intensity" and "duration" in lieu of the term "dose" used in this MP; and they define the term "dose" to include intensity, duration, and frequency (Shanahan et al., 2016a). Unfortunately, the academic community has not arrived at globally accepted meanings for terms like "dose," "intensity," and "frequency."

A wide array of "natural" settings is used for NT (Wolf et al., 2020). To the right is a slide that shows a spectrum of nature contact and exposure types – from large wilderness areas to views of trees out of a building window to natural daylight in buildings. Research studies examining nature-health relationships have studied the effects of "nature" in this wide range of forms (Hartig et al., 2014) (all of which appear to benefit people either in experiments or anecdotally in practice). However, research has not yet been able to isolate particular aspects of nature (or quantify the amount/abundance of natural features) that cause particular human health outcomes (Wolf et al., 2020) (Fisher et al., 2021).[8] However, there is published research and anecdotal evidence (as well as theoretical extrapolations from proposed "pathways" to health) that more abundance (e.g. greater forest tree stand density) and greater species richness have greater positive health effects on the body (Wolf et al., 2020).



Based on a synthesis of all my research[9], the optimal dose is achieved when the nature setting is characterized by the following:

- ◊ Sensory Immersion and Visual Complexity (without over-stimulation)
- ◊ Setting Enables Focus Attention and "Presence" in the space (i.e. removal of distractions)[10];
- ◊ Abundance of Nature; Biodiversity/Species Richness;
- ◊ Setting Promotes a Sense of Awe, Fascination, and Peace;
- ◊ Setting Encourages Appropriate Activity/Exertion Level for Disease/Treatment;
- ◊ Fresh Air and Thermal Tolerance

These characteristics are all optimized with nature spaces at or near the top of the nature spectrum.

Views on the minimum and optimal therapeutic length of exposure in (or duration of) a nature therapy session was wide ranging, and AR1 emphasized that optimal duration of exposure will vary with age and preexisting disease/health state. P2 led therapy practices over 2–3-day periods and suggested that at least 2-hour durations were helpful for optimal health benefits. AR1 stated that a minimum 20-minute duration was normally essential. Shanahan et al. state that at least 30 minutes/week is necessary for a health benefit (Shanahan et al., 2016b). Other research studies suggest that longer durations are more restorative: Scopelliti et al. explain that, for restorative processes, the restoration process may proceed through several

[8] 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.

[9] In addition to support for this finding in the literature review, the following also support these findings: Personal Communications with AR1, AR2, P2, and P4. See also design principles set forth by NatureSacred: https://naturesacred.org/our-work/product-design/

[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. Attention Restoration Theory argues that the experience of "being away" is essential for health (Hartig et al., 2003).

stages (e.g., "ranging from clearing one's mind to renewing directed attention mechanism, to possibility for reflection on personal issues") (Scopelliti et al., 2019).

B. LOCATION/ACCESS: PROXIMITY

Geographic-spatial relationships have important effects on the health efficacy of 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" (Bratman et al., 2019). Proximity is important for at least two reasons:

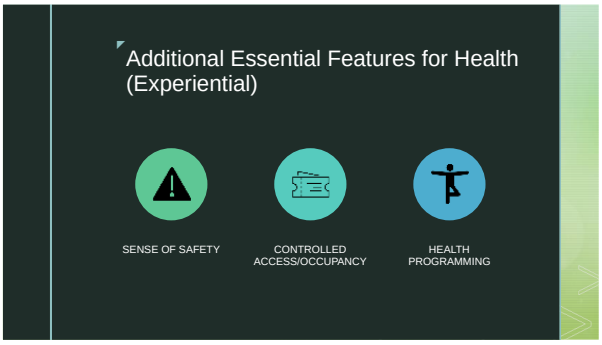
1. Localized Environmental Benefits (e.g., pollutant reduction; heat island mitigation) (Jones et al., 2019)
2. Ease of Access – Supports Frequency.

C. TEMPORAL EFFECTS: FREQUENCY

Frequency relates to how often a patient is exposed to nature and health programming over time. **Generally, regular exposure over long periods of time optimizes health outcomes**. Academic Researcher 1 stated that repetitive exposures (particularly as a regular weekly routine), with an approximate minimum of 120-150 minutes/week, creates a sustained benefit (Personal conversation with AR1). Due to the dearth of longitudinal studies on nature therapies, there is little scientific evidence on how long (e.g., weeks, months, or years) the exposures must occur to have lasting health effects. According to Practitioner 2, health effects of multi-day immersive camping experiences begin to dilute over the course of months if not otherwise maintained by frequent localized nature experiences.

D. ROLE OF SUBJECTIVE EXPERIENCE OF NATURE & IMPORTANCE OF HEALTH PROGRAMMING

Interviews then revealed the extreme importance of the individual's subjective experience of safety, sense of place, and, in some cases, feelings of empowerment while engaging in the NT (Personal communications with AR1, AR2, and P2).[11] That is, that extent to which the natural space delivers a health effect depends, in part, on the patient's enjoyment of (or past trauma with) certain natural features (i.e. what kind of nature does the patient most enjoy and feel comfortable in). It can also be very ethnic-culturally dependent as well as trauma-affected (Hartig et al., 2014; Finney, 2014). So, effective NT at the individual level must also consider factors that affect *each individual's experience of personal safety, physical limitations, and understanding of natural features.* These considerations will affect how many people should be present in a NT session, whether it should be guided, how much immersion in nature is appropriate, and cultural cues of the space (Personal communications with AR2 and P2).



[11] Among my interviewees, very few of them operated forest-bathing programs or nature experiences in local, urban forests. However, one practitioner operated hiking and camping in large forests, and the Green Road at Walter Reed was done as part of a stream restoration within a forest buffer.

As discussed, the setting and program must engender a feeling of safety before the space can have a healing effect (Personal communications with AR1, P1, P2, AR2, P4). Due to the importance of subjective experience, NT may be more successful (and attended) if there are programmed sessions – as opposed to an expectation that someone go to a green space alone for self-treatment. Some people will self-determine that NT is appropriate and important for themselves and expose themselves to nature on their own. But often, people are more successful when the human-nature connection is moderated (e.g., when people are shown how to interact with nature for maximum health benefit), when people are together in group sizes appropriate for the treatment of their diseases, and (iii) and 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. For these reasons, and because one potential pathway for health effects is social cohesion, AR2 believes that NT is best undertaken in group sizes of approximately 5-12 people, and P2 believes that optimal group sizes occur in the 20-25 person range in programming where people can separate and engage in different activities (but come back together for group events or meal times).

Special note on active recovery/rehabilitation and NT: For people recovering from stroke or in need of active rehabilitation, certain design features of the natural area are important (Hazen, n.d.) According to Practitioner 4, 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 urban forest patches can provide.

Crowding/Maximum Occupancy. When considering whether there are "maximum occupancy" measures for certain size spaces – we must consider both physical limitations and subjective experiences. Given how little information there is on the relationship between group sizes in a space and optimal health effects, I looked at studies of overcrowding at certain high-profile, high-traffic parks and the boundary at which crowding becomes unpleasant for people. The main study I found was from China, which suggested that there should be *no more than* 1 person per square meter (Guo et al., 2019); Guo et al. observed that, among the range of tourist group sizes, there were ideal sized groups, acceptable sized groups, and crowded groups at viewing locations of popular sites (Guo et al., 2019). The researchers noted that crowding not only became unpleasant for tourists, but it also became dangerous and damaging to the site itself. The upper boundary suggested by Guo et al. would translate into a cap of approximately 2100 people in a ½ acre parcel. However, this number must be mediated by considerations of health programming, creating spaces that can meet dosage requirements, and the subjective experiences of personal safety (discussed above), all of which may substantially limit the maximum number of people in the space below an "overcrowding" threshold. It is also clear that overcrowding in a space can lead to ecological damage – as evidenced by the experience of certain public parks (i.e. Great Falls National Park (*Beautiful but Crowded - Review of Great Falls Park, McLean, VA*, n.d.) (Wimpey & Marion, 2011)

https://pubs.er.usgs.gov/publication/70004552) Overcrowding is becoming recognized as a problem: https://www.nationalparkstraveler.org/reader-poll-are-crowds-parks-concern. Therefore, any nature setting that optimizes health will have to be a place in which owners and operators are able to control and manage total occupancy and crowding.

FINDING #4: HEALTH FORESTS: THE OPTIMAL SOLUTION

FORESTS AS THE OPTIMAL CHOICE ON THE NATURE SPECTRUM

The optimal choice on the nature spectrum is native forest patches for the following reasons: forests provide the best nature context because forests offer most (or all) of the natural features that are important for NT. In most cases,[12] for individual participants, the best choice will be high on the nature spectrum, ranging from wilderness adventures to forests and forest patches. Selections on the "nature spectrum" below forest patches (e.g., street trees or exercising in a yoga studio with a view of vegetation) are suboptimal because they do not optimize dose (and for additional ecological reasons listed below). On the other hand, to ensure proximity to urban populations and sufficient frequency, the nature space must be located within cities and close to target populations; therefore, I excluded wilderness adventures because these are not available or replicable in the urban space, while native forest patches are.

Forests (whether young or old) appear to accommodate the range of people's enjoyment and/or tolerance of nature – even if permanently disabled (Hansen et al., 2017; Personal communication with P2; Wolf et al., 2020). For some people, urban forests may be on the outer edge of their comfort level with nature (however, these discomforts can be managed with small open areas, areas that provide shelter, and health programming); for others, urban forests may not quite be sufficient to achieve the dosage needs like a wilderness experience (but this can be managed by creating feelings of immersion in nature and seclusion).

Additional considerations: The optimal point on the Nature Spectrum will also seek to maximize:

(i) the positive health outcomes for the broadest range of costly diseases, and
(ii) ecosystem services and ecosystem health for the local area.

Finally, forests are the most studied nature setting, and they are the native habitat of the mid-Atlantic piedmont areas, which is the geographic focus of the MP.

HEALTH FORESTS AS THE OPTIMAL SOLUTION

Urban forest patches allow for the individual experience of sensory immersion in nature. They are the kind of "nature" that can optimally meet key health and environmental restoration goals. They can be designed for safe and experiential learning. And, when located in residential neighborhoods or near office/mixed-use locations, they can provide the access, proximity, and frequency that optimizes health outcomes. In fact, the need for proximity, easy access, and frequent exposure suggest that locating "nature" close to where people live or work is extremely important for effective NT with long-term outcomes – more important than locating these spaces at hospitals that are not within walking distance for the target

[12] 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 (Hazen, n.d.)

population. Forests may also maximize certain chemical nature-body interactions (i.e. exposure to phytoncides) (Li, 2010).

Additional parameters derived from the above findings are as listed in the slide to the right.

Given the parameters and viable opportunities, urban forest patches in the size range of ½-1 acre appear to strike the ideal balance between maximizing health outcomes and maximizing ecosystem restoration/climate resilience outcomes.

Is there a minimum size area? This question relates both to achieving the optimal dosage of nature and the subjective experience of having the "feel" of being in nature both of which are necessary for the greatest health benefit. During the interviews, it became clear that there is no established size of a space that will determine health efficacy – the required size of the space will necessarily depend on the abundance and biodiversity of nature in the space, the illness at issue, the individual's health treatment program's psychological or physiological goals, the individual's comfort level with different kinds of "nature" and different size groups of people (see "Role of Subjective Experience" above), and the land uses surrounding the natural area (Personal communications with AR1, P1, P2, P3, AR2, P4).

HEALTH FORESTS AND PRIVATE OWNERSHIP

Outside of hospital settings, most NT operations rely on public lands for their operation. However, for NT to be maximally effective, it is essential to be able to (i) control (or manage) the landscape design for health and ecology – in terms of vegetation, variability, structure, and spatial layout; (ii) to control occupancy (in terms of which and 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 NT is behaving in a way that is compatible with NT uses of the space); and (iii) to ensure the space is maintained in ways that are optimal for the health and environmental purposes of the space. Without privately owned (or use-restricted) property, it is extremely difficult, if not impossible, to perform NT on a steady and regular basis while maintaining these kinds of controls.[13] Existing public parks and open spaces, in which health operators cannot control who enters and exits the space during health programming (or ensure such entrants use the space in a manner compatible with health programming), cannot achieve optimal health outcomes.

[13] Whether it is possible (i) for the federal government to operate health forests under the stated parameters or (ii) for private entities to own and operate the space with the stated parameters using federal medical funding sources is outside the scope of this paper.

FINDING #5: WHICH HEALTHCARE ENTITIES HAVE THE GREATEST FINANCIAL INCENTIVE TO REDUCE EXPENDITURES WHILE MAINTAINING PATIENT OUTCOMES?

The entities with the greatest potential gain are:

Most to Gain

- Self-ensured employers (Personal communication with HC2)
- Closed-System Integrated Managed Care Organizations, like Kaiser Permanente (Gamble, 2013)

Potentially High Gain

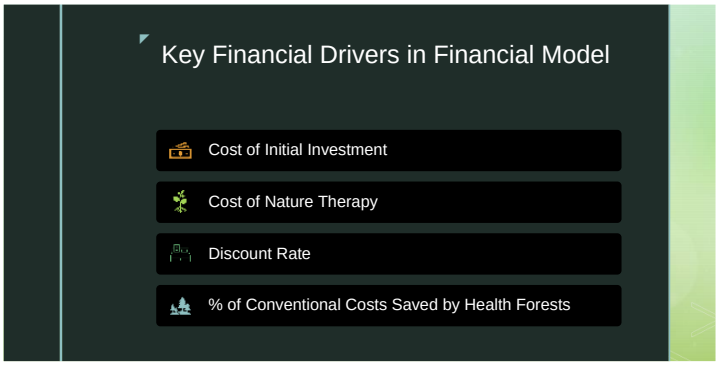
- Private healthcare insurance companies

This is partly because corporate healthcare payers need to be concerned about population level expenditures as well as patient-specific expenditures. 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 (*2020_Update_Altarum-Hub_RB_1_-_Hospital_Rate_Setting_Final.Pdf*, n.d.) (Personal communication with HC2). It is possible that states could revise healthcare payment structures, similar to Maryland's "all payer" rate setting model (*2020_Update_Altarum-Hub_RB_1_-_Hospital_Rate_Setting_Final.Pdf*, n.d.), that would cause hospitals and out-patient providers to have greater financial incentives to reduce healthcare expenditures, but for now, the primary healthcare payers who stand to gain from this exploration are health insurance companies and self-insured employers. Self-insured employers have the most to gain from Health Forests because, even to the extent that covered healthcare expenditures are not avoided, the benefits of improved health and well-being still accrue to the employers in increased productivity, employee engagement, and reduced employee turnover (Personal communication with HC2).

FINDING #6: HEALTH FORESTS ARE FINANCIALLY FEASIBLE IF THEY CAN AVOID AT LEAST 20% OF COVERED HEALTHCARE EXPENDITURES

As noted above, the financial model estimates the costs of creating and operating an optimized Health Forest and then determines the net present value of the cost savings that the nature-based treatment could generate for private healthcare payers. More specifically, the financial model examines the financial effects of replacing certain conventional CVD treatments (and their associated expenditures) with NT treatments, and avoided costs are treated as revenues to the healthcare payer.

Given that Health Forests could have substantial therapeutic effects on CVD and other diseases with similar pathologies (like hypertension), they could likely achieve a cost savings threshold necessary to be financially feasible. In the financial analysis, the key drivers of whether Health Forests are financially feasible are (i) the cost of the initial investment to create the Health Forest, (ii) the cost of running nature therapy programs, (iii) the discount rate, and (iv) the ultimate dollar cost savings created by the use of Health Forests in lieu of conventional treatments. The model reflects that there is tremendous potential for cost savings using health forests. As more conventional costs are offset, NPV rises drastically.



Net avoided costs [assuming 80% insurance payment of patient costs]	*$$ investment @ 10% discount rate*	*NPV*	*IRR*	*Max. per sf initial capital investment*
40% net avoided costs	$609,840	$169.30/SF	112%	$366.60/sf
30% net avoided costs	$609,840	$97.63/SF	79%	$223.26/sf
20% net avoided costs	$609,840	$25.96	37%	$79.92/sf
15% net avoided costs	$609,840	-$9.87/SF	-12%	$8.25/sf

At 15% of avoided conventional costs, a payer will only get positive returns if:

⇒ the discount rate is around 5%,
⇒ the initial capital investment is reduced to $179,691.43 (keeping 10% discount rate), or
⇒ the healthcare payer covers more than 80% of healthcare expenditures (e.g. 90%)

The main driver of financial outcomes is the size of the expenditures that can be avoided by substituting conventional treatment with Health Forests. This is the primary determinant of financial feasibility.

Viability. As shown in the chart above, I calculated the maximum initial investment that a payer could make, in different cost saving scenarios, and still achieve a positive return. For example, in a 30% savings scenario the initial investment would be capped at $223.26/sf. Since purchasing the land is the bulk of the initial investment cost, the payer would have to be able to find land for sale under the applicable price cap. Based on a simple search of real estate in Washington DC and Baltimore, I found land sales prices in D.C. ranging from $29/sf to $100/sf in lower cost (but gentrifying) neighborhoods. Land sales prices in Baltimore ranged from $5/sf to $144/sf around the central city.

KEY ASSUMPTIONS THAT DETERMINE HOW MUCH FINANCIAL VALUE CAN BE CREATED (AND FACTORS THAT AFFECT THESE ASSUMPTIONS) ARE:

1. Savings Scenario/Total value of Avoided Costs. If conventional costs (i) are substantially reduced for some other reason, or (ii) Health Forests are not able to offset at least 20% of covered expenditures, the financial value of the forests is reduced. However, the financial model assumes that healthcare payers fund the entire acquisition, operation and maintenance, and health programming budget, which does not necessarily have to be the case. Returns to healthcare payers could be substantial even in a low net cost avoidance scenario if another entity funds part of these establishment or operating costs.

2. Land acquisition (and potential demolition) costs. Much depends on land costs (including size of space) and how many people can be treated (so that average cost savings are sufficiently high and predictable). One finding is that a ½ acre forest can have a meaningful impact on 500-1000 people/year. Although this may make financial sense, I presume it is of insufficient scale to be worth the effort of trying it – however, this is a small enough sized piece of land that health forests could be installed in every neighborhood – and maybe multiple health forests pr neighborhood. As you scale up the number of health forests, you scale up the population that can be served. You also improve other health measures of the entire surrounding community at the same time.

3. Discount rate. The financial model used a reasonably conservative estimate of 10% as the discount rate, despite common weighted average cost of capital ranges in the 7-9% ranges (though increasing inflation may make higher figures more realistic). However, the potential need to use equity only would impose a higher cost of capital – potentially in the 12-15% range (F. Greene III, personal communication, February 5, 2022).

4. Conventional costs normally paid by private corporate healthcare payer. Note that a 3rd party health insurance payer probably pays substantially lower % of healthcare costs than a self-ensured employer, but a self-insured employer will reap greater benefits from employee health than a 3rd party insurer.

The best way to maximize financial returns is to identify low-cost land to purchase,[14] to purchase many, spatially distributed ½ acre to 1-acre parcels of land (ideally vacant land, but possibly with small structures on them), and locate the forests in neighborhoods with high rates of heart disease (or disease risk factors, including low-incomes, high levels of hypertension or diabetes, heat islands, and reduced access to safe, outdoor recreational areas) as close to concentrations of insured members as possible.

FINDING #7: HOW LARGE COULD THE FINANCIAL RETURNS FROM HEALTH FORESTS BE?

There is insufficient medical data to know precisely which conventional heart disease expenditures Health Forests can replace. However, looking at heart disease data, we see that healthcare payers can gain high returns from either (i) large population-scale reductions in prescription drug use and office-based care for heart disease treatments, (ii) from avoiding deterioration cascades from early stages (or risk factors) of heart diseases into the most expensive health treatments (e.g., inpatient hospital stays), or (iii) pure prevention of heart disease entirely.

[14] I note that the financial model did not examine the financial benefits of using low-cost debt to purchase land or pay for other initial investment costs, which could also improve financial returns.

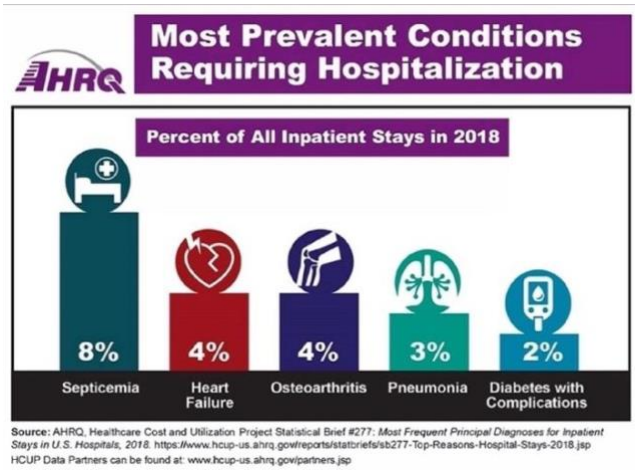
Common Treatment Types	*Most Expensive Treatments*
2017 allocation of CVD expenditures by treatment type for heart disease: 1. 71.5% had prescription drug expenses, 2. 67% had expenses for medical providers' office-based care. 3. 15.2% had outpatient hospital visits, 4. 13.6% had emergency room visits, 5. 12.7% had inpatient hospital stays, and 6. 6% had home health visits.	Total medical expenditures for heart disease broken down by most-to-least expensive treatment type: 1. Inpatient hospital care – 54.8% of CVD expenditures (most expensive) 2. Home health care – second most expensive 3. ER & Outpatient hospital care 4. Office Based Care 5. Prescription drugs – 11.6% of expenditures (least expensive)

(Rama, n.d.)

Most CVD treatments rely on prescription drugs and office-based medical care, which are likely susceptible to nature therapies. Given that the vast majority of heart disease patients are treated with prescription drugs and office-based care – there is a meaningful likelihood that these kinds of expenditures can be drastically reduced with NT (depending on the reasons for the prescription drug use and office visits).

It is also the case that the most expensive treatments of heart disease are in-patient stays and ER/Out-patient hospital treatments. Inpatient stays are 54.8% of annual CVD treatment expenditures (even though they represent only 12.7% of the treatment types used for CVD patients).

Furthermore, if we look at total national healthcare spending, we see that CVD is the second most common reason for hospital stays – and hospital stays are 31% (or the largest percentage of healthcare expenditures across treatment types) (*STATISTICAL BRIEF #531: Healthcare Expenditures for Heart Disease among Adults Age 18 and Older in the U.S. Civilian Noninstitutionalized Population, 2017*, n.d.-b). Hospital stays are extremely costly and if Health Forests can reduce them among patients at risk of heart failure, healthcare payers could have a very strong financial justification for investing in them. The image to the right shows that heart failure caused the second highest number of inpatient hospital stays in 2018.



If the largest expenditures for heart diseases can be reduced by even small percentages either through (i) pure avoidance (i.e. prevent certain serious diseases before they start) or (ii) through reductions of cascading disease severity after early indicators (e.g. hypertension evolving into heart attack), healthcare payers could see substantial cost savings.

<u>*Note on Co-Morbidity and Expenditures*</u>: Research suggests that Health Forests can also minimize related risk factors (from hypertension, diabetes, and mental health illnesses that can lead to serious acute and

chronic health diseases) and co-morbidities.[15] Although the MP financial model focuses exclusively on heart disease costs for the sake of simplicity, diseases like hypertension, depression, diabetes, and heart disease often interact with each other (and accelerate deterioration) within individual patients – and they are considered co-morbid diseases. Because initial investment in Health Forests (as shown in the model) is a fixed cost, avoiding costs for additional and co-morbid diseases adds support to the notion that the model underestimates expenditure reductions.

However, this question has not been adequately studied at large scales for CVD patients. There is almost no longitudinal evidence that demonstrates how long NT's effects last or how long one must engage in NT to have beneficial outcomes. There is very little peer-reviewed research that examines the extent to which NT can reduce healthcare costs (especially those borne by corporate healthcare payers) and how much of those costs it can avoid. These questions are ripe for further research, as discussed below.

DISCUSSION/IMPLICATIONS

Given the dual need for (i) environmental solutions to climate mitigation and adaptation and (ii) improving health outcomes while reducing healthcare costs, it is surprising that unified solutions to these two issues have barely been considered by the healthcare industry (or the environmental sector). As my findings reflect, Health Forests could play an potent role in solving the problems of urban environmental and health deterioration in the mid-Atlantic United States. Yet, to break through both paradigmatic and operational obstacles, we need to fund targeted research that can refine the financial model I have presented here.

HEALTHCARE PAYERS SHOULD FUND FOCUSED RESEARCH ON THE COSTS AND BENEFITS OF HEALTH FORESTS AS A MEDICAL TREATMENT OPTION

HEALTHCARE SECTOR PAYS LITTLE ATTENTION TO THE POTENTIAL OF NATURE THERAPIES

Interviews revealed that (i) medical/healthcare sector has little to no knowledge of NT, when and how they are useful, or how much they cost to implement; (ii) few in either the medical professions or environmental advocates have seriously considered synergies between environmental benefits and reducing healthcare costs, though conversations about NT have been stimulated (mostly in public health) by:

- COVID-19 (and the need to be outside to be safe and healthy),
- Climate change-related diseases and natural disasters as public health issues,
- Equity and inclusion considerations, such as inequitable distribution of health risks, climate risks, and urban green space, and
- Children and declines in mental health.

One example of the medical community's lack of awareness appears on the website of the State of Maryland's Center for Chronic Disease Prevention and Control states:

[15] 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 (Haahtela et al., 2021).

Chronic diseases, including heart disease, stroke, and diabetes, are among the leading causes of death in Maryland and currently account for 75 percent of health care costs. Fortunately, the majority of chronic disease cases can be prevented. Eighty percent of heart disease, stroke, and diabetes can be prevented through proper nutrition, physical activity, and not smoking.

While "Environmental Approaches" is listed as one of the action areas of the MCCDPC, the website does not mention the presence or use of nature as a therapeutic component that is necessary or important for the prevention of the top diseases of concern. https://health.maryland.gov/phpa/ccdpc/Pages/ccdpc_home.aspx https://health.maryland.gov/phpa/ccdpc/heart/Pages/prevention.aspx

HEALTHCARE SECTOR NEEDS TO SEE THE OPPORTUNITY IT IS MISSING

Health Forests can offer triple bottom line benefits for corporate healthcare payers – particularly in urban areas with high percentages of impervious surface and among covered populations with high prevalence of CVD or risk factors for CVD. The potential ESE gains – particularly the potential economic returns shown in the financial model – justify further examination with refined cost information and better treatment effectiveness research.

Chronic diseases are among the most prevalent and costly health conditions in the United States. Nearly half (approximately 45%, or 133 million) of all Americans suffer from at least one chronic disease, and the number is growing. Chronic diseases—including, cancer, diabetes, hypertension, stroke, heart disease, respiratory diseases, arthritis, obesity, and oral diseases—can lead to hospitalization, long-term disability, reduced quality of life, and death. In fact, persistent conditions are the United States' leading cause of death and disability (Raghupathi & Raghupathi, 2018). At the same time, it is precisely these kinds of chronic diseases that Nature Therapy is most effective at treating.

Corporate healthcare payers (whether insurance companies or self-ensured employers) are best suited to pay for Health Forests located among populations whose healthcare costs they would otherwise pay for. These healthcare payers stand to reap substantial financial gains (and they have access to funding to cover the initial investment) if they fund and implement Health Forests that are optimally designed and located.

Health Forests can be expected to drastically reduce healthcare expenditures for CVD if conventional treatments are replaced with consistent, high-quality NT. As shown above, the internal rate of return (IRR) for such investment could be as high as 37% under a moderate-conservative scenario of avoiding 20% of covered patient expenditures through Health Forest interventions.

CLEARING THE OBSTACLES

Despite the tremendous potential for Health Forests to substantially ameliorate some of our gravest problems for high returns on investment, corporate healthcare payers have not pursued this opportunity. There are a number of reasons for this disconnect (including that they don't know NT exists or they are not aware of the current state of research on NT), but the most formidable obstacles are:

(i) They don't have sufficient published medical evidence showing which health expenditures can be offset (personal communications with HC1, HC2, D, and ICE), and

(ii) They do not know how to implement Health Forests to capture projected financial and health benefits (and they don't see their role as delivering environmental benefits).

Unfortunately, despite the growing number of research studies about the health effects of nature on the human body, there continues to be insufficient medical data that can be used to justify the financial investment at this time. As discussed in the Results section, the growing body of academic research on the effectiveness of NT is mostly conducted through the fields of landscape design and public health. Generally viewed as insufficient by medical decision makers, these studies also rarely emphasize how NT might ***quantifiably reduce costs currently borne by corporate healthcare payers*** (Fisher et al., 2021). Because local community-based nonprofits or schools are experimenting with NT, there are increasing amounts of anecdotal evidence on the effectiveness of NT, but very little formal measurement or study in the U.S. or among diverse populations (in terms of age, gender, ethnicity/culture, and racial demographics) or longitudinally to show long-term effects. (Wood, 2017; Fisher et al., 2021)

Therefore, it is essential that more research be done to study not only the health effects of NT on high-cost diseases, but it is also essential that such research quantify the financial benefits using NT that is optimized for health and environmental outcomes as well as cost savings. If the studies do not optimize the NT, they will not accurately reflect the maximum potential cost savings that can be achieved.

NT HAS TO BE IMPLEMENTED OPTIMALLY WHEN PEOPLE MEASURE ITS FINANCIAL, HEALTH, AND ENVIRONMENTAL OUTCOMES

HEALTH FORESTS MAXIMIZE HEALTH AND ENVIRONMENTAL OUTCOMES

Urban forests in the size range of ½-1 acre appear to strike the ideal balance between maximizing health outcomes and maximizing ecosystem restoration/climate resilience outcomes, within urban spatial and cost constraints.

HEALTH PROGRAMMING IS ESSENTIAL

As noted above, however, each individual's subjective experience of the NT – particularly in terms of feelings of safety – will have a large effect on the health outcome of the NT. This experience, for residents of highly urbanized areas, will normally benefit from health programming to help people understand why and how the space is safe and to allay concerns that may arise due to personal fears or cultural-ethnic-historical associations with forested areas (or the particular design of the space). While the design itself may provide for safety cues and areas of refuge, it is essential that people be guided in the health promoting activities, with demonstrations of how to interact with nature safely and respectfully, and that people have opportunities to lessen exposures to features that may unintentionally create fear or discomfort. 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 sub-groups, distracting or disrespectful individuals, and any other hazards related to bringing diverse groups of people together for rehabilitative treatments.

REGENERATING DISTRIBUTED[16] HEALTH FORESTS ACROSS AT-RISK URBAN NEIGHBORHOODS IS ESSENTIAL FOR SUCCESS

To meet the frequency, proximity, and temporal requirements for successful NT, Health Forests should be walkable from where covered patients live (or spend the bulk of their time), and ideally visible from their location. [The importance of proximity, and frequency of exposure to nature over extended periods of time is so important 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 (*3-30-300*, n.d.) 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 300 meters (.186 miles) should be the maximum distance to the nearest high-quality public green space. (*UNECE Supports Sustainable Urban and Peri-Urban Forestry for Public Health, Climate Resilience and Green Recovery | UNECE*, n.d.). This approach also maximizes ecological impact in urban space.

EXISTING FORESTED AREAS (PARTICULARLY URBAN PUBLIC PARKS) ARE INADEQUATELY DESIGNED AND MANAGED FOR MEDICAL COST-BENEFIT RESEARCH

In urban areas, parks are often inequitably distributed (and it is common to find fewer parks in areas with higher risks of CVD) (Sammis, 2020), parks are often not forested when they are present, they are not specifically designed to maximize health and ecological outcomes, public parks generally cannot or do not control occupancy to ensure that health metrics and programming parameters are met, they are not already operated with health programming in place, and they are often not well maintained. These problems can contribute to a vicious circle in which disinvestment leads to other uses (or non-use) and such behavior then leads to further disinvestment (Sammis, 2020).

EXISTING URBAN FOREST AREAS ARE TOO FEW, NON-OPTIMALLY LOCATED, AND DO NOT SATISFY KEY FEATURES OF HEALTH FORESTS

Most urban areas in the mid-Atlantic need more park areas to serve the growing populations. However, intense competition for land from residential and commercial housing development, as well as public services like police, fire, recreation, and public buildings make parks difficult to expand and create – particularly with limited public funds. As a result, existing parks are often crowded, over-utilized, and under-maintained. Such areas are not only suboptimal as Health Forests, but their condition also indicates a clear need for more forested areas, rather than adding new uses to already over-burdened forested park areas. Even where public parks do offer healthy forested areas that could be used as "Health Forests," however, these areas are not widely distributed spatially for ease of access by large numbers of affected people.

[16] The author notes that not all environmental scientists agree on the best spatial configuration for urban green spaces or forest patches across urban metropolitan areas when seeking to support and promote biodiversity. This MP contemplates an increase of Health Forests in otherwise vacant lots can only benefit biodiversity by adding forest patches where none exist today. However, questions related to this issue are beyond the scope of this MP.

HEALTH FOREST CREATION AND IMPLEMENTATION NEED INNOVATIVE FOR-PROFIT/NONPROFIT PARTNERSHIPS TO CREATE, FUND, AND MANAGE

In today's mid-Atlantic cities, urban forest restoration projects, which themselves are few and far between, are most likely to be funded by state or local governments, generally to mitigate environmental damage elsewhere or to comply with clean water mandates. Yet, there is essentially no funding available to regenerate forests for health and ecological purposes at the same time – especially in urban areas. To the extent people have begun to research the importance of nature-health connections, rarely does the research examine the cost of such solutions or who should pay for them.

If Health Forests could be funded and implemented by corporate healthcare payers to address this void, then it makes sense for healthcare payers to acquire, own, and operate the Health Forests to maximize health and financial returns. The public sector is not equipped to own or operate Health Forests under the parameters listed for maximum health and ecological benefit, and the public sector has major political, financial, and potential legal impediments to implementing Health Forests for the target populations or the general public.

However, 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, or managing natural lands for long periods of time. While corporate healthcare payers could build this expertise up in house or contract out for it, doing so would be a substantial change of standard operations and require a high-level organizational commitment to such an effort.

In addition, corporate healthcare payers will have incentives to take a couple of undesirable actions:

(i) They will seek to serve as many people as possible within each Health Forest per day, without increasing programming or operation and maintenance costs in the process. This may incentivize crowding to the point where health and ecological outcomes are suboptimal but still cost reductive.

(ii) Healthcare payers will not have incentives to maximize environmental/ecological value of Health Forests, except to the extent that such ecological value is essential to health outcomes (which has not fully been established in the literature yet). Healthcare payers will have every incentive to reduce the costs of developing and operating Health Forests as much as possible while achieving net reductions in healthcare expenditures.

As a result, a nonprofit land trust (with experience managing parks, forests, or other natural resources used for recreation) or private forest/land manager partners may create the right balance for optimizing Health Forests without introducing the limitations associated with government involvement. To reduce the costs of an anticipated learning curve in piloting these kinds of partnerships, federal or state governments should consider financial or tax incentives for successful implementation of Health Forests. Precise partnership and legal structures of ownership, operation, and financing require further examination, all of which can benefit from pilot projects designed to assess optimal arrangements.

CONCLUSION

We are at a point in time where NT – and specifically Health Forests – can be a key component of the U.S. response to lowering health care costs and addressing numerous environmental challenges.

In conclusion, my findings suggest:

1. Nature in cities can be potent solution to major social and environmental problems that has not been examined adequately;
2. The best kind of "nature" for Nature Therapy in non-coastal mid-Atlantic cities (most of which are located in Piedmont geographic zones) is Health Forests;
3. Investors currently paying for healthcare expenditures to treat the most expensive chronic diseases stand to create substantial value and financial returns by investing in Health Forests as imagined in the financial model presented.

It is essential that researchers conduct further research on (i) features of Nature Therapy that can maximize health efficacy without sacrificing ecosystem services, and (ii) the type and size of conventional health expenditures that can be replaced with NT. This will require healthcare payers and medical officers to develop health efficacy metrics for NT (i.e., the desired metrics for evidencing improved health outcomes from nature therapies) by which to measure performance. The performance metrics should establish parameters for minimum required improvement scenarios, good improvement scenarios, and ideal improvement scenarios – based on how much financial return can be achieved in the financial model from those levels of improvement. Such metrics would provide parameters for researchers to model the benefits of NT in a way that could demonstrate sufficient medical efficacy and valuable financial returns. Researchers should also examine the Biodiversity Hypothesis. While there is evidence that health outcomes improve with biodiversity, research should study whether it is necessary to achieve health outcomes. If so, healthcare payers will also have financial incentives to maximize ecological outcomes.

Unfortunately, there is a time pressure to using NT as a solution to the crises discussed here for at least two reasons:

(i) Ecosystems of all types are under increasing stress from climate change and human degradation – to the point where, subject to continued degradation into the future, they may no longer be able to provide the health benefits they do today; and

(ii) Urban populations are increasingly distanced from natural settings and urban areas have created modern living habits that have reduced regular contact with outdoor nature and increased time spent indoors on screens and performing sedentary activities. "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" and "extinction of experience" that shifts the baseline of reference points for the acceptable quality, richness, and variation in nature experience." – while this may be adaptive for lives lived increasingly divorced from nature, it dilutes life experience and simultaneously makes increasingly afraid of nature as the "unknown." (Bratman et al., 2019)

The rise in mental illness, attentional disorders, heard disease and diabetes (even prior to the /COVID pandemic) (*Division of Diabetes Translation | CDC*, 2022) suggests that, not only physical activity but also connection with nature are essential for humans to thrive (*Improving Health and Wellness through Access to Nature*, n.d.). As stated by Chaudhary and Bannerjee: "There has been a worldwide shift [to urbanization and a "gadget-oriented world of televisions, computers, and gaming…] [has] led to a decrease in exposure to natural environments. There is also evidence of an increase in the worldwide prevalence of mental disorders concurrent with urbanization. These two trends may be linked with decreased exposure to nature causing changes in psychological functioning as suggested by growing evidence." (Chaudhury & Banerjee, 2020).

If we want to counteract this process, we must expose urban populations to rich and varied natural settings and learn how to live with them. This will also enable a healthier habitat for other species as well as humans. As ecosystems degrade and environmental amnesia takes hold, the ability of Nature Therapies to achieve meaningful advances also deteriorates. And, as environmental amnesia takes over, the "market demand" or popular push for creation of these nature spaces weakens and gives way to technological and pharmaceutical responses that are more lucrative to produce and sell. In addition, as urban populations continue to grow, land becomes increasingly scarce and expensive – potentially placing the cost of land for Health Forests out of reach.

Additional medical/interdisciplinary research on the health effects of different kinds of NT interventions is necessary, but preliminary evidence suggests that corporate healthcare payers should take note of the potential financial benefits of supporting this research, and purchase land for Health Forests now. Experimentation with NT and urban land acquisition are wise moves now, as land values and health expenditures rise.

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Definitions

Heart disease

In the MEPS-HC, the medical conditions reported by respondents are recorded by the interviewer as verbatim text. Since 2016, medical conditions have been coded to fully specified International Classification of Disease, 10th Revision, Clinical Modification (ICD-10-CM) codes (ICD-9-CM codes that were used in prior years were phased out). For this Brief, conditions were regrouped into categories labeled as Clinical Classifications Software Refined (CCSR), which were designed to be as clinically homogeneous as possible. The following CCSR categories were used to identify heart disease.[3]

CCSR Category	Description
CIR001	Chronic rheumatic heart disease
CIR002	Acute rheumatic heart disease
CIR003	Nonrheumatic and unspecified valve disorders
CIR004	Endocarditis and endocardial disease
CIR005	Myocarditis and cardiomyopathy
CIR006	Pericarditis and pericardial disease
CIR009	Acute myocardial infarction
CIR010	Complications of acute myocardial infarction
CIR011	Coronary atherosclerosis and other heart disease
CIR012	Nonspecific chest pain
CIR013	Acute pulmonary embolism
CIR014	Pulmonary heart disease
CIR015	Other and ill-defined heart disease
CIR016	Conduction disorders
CIR017	Cardiac dysrhythmias
CIR018	Cardiac arrest and ventricular fibrillation
CIR019	Heart failure

Unlike a previous Statistical Brief on the same topic,[4] the present Brief excludes heart murmurs in the classification of heart disease.

- Chronic condition: "is a physical or mental health condition that lasts more than one year and causes functional restrictions or requires ongoing monitoring or treatment." (Raghupathi & Raghupathi, 2018)
- Health Forests: a term created specifically for this MP to refer to urban forest patches that enable patients to feel immersed in nature that are owned and managed specifically for health programming and NT.
- Forest Bathing: any attempt to perform or replicate Shinrin Yoku.
- Forest Therapy: forest bathing, or other forms of social and therapeutic uses of forests, which may include silviculture, green exercise, environmental conservation and wilderness therapy.
- Native Forest Patches: small, forested areas or forest fragments characterized by the species and structure of predevelopment habitat for the local area.
- Nature: physical features and processes of nonhuman origin that people ordinarily can perceive including the 'living nature' of flora and fauna, together with still and running water, qualities of air and weather, and the landscapes that comprise these and show the influence of geological processes (Hartig et al., 2014). Nature includes fragments or intact sections of natural ecosystems.
- Nature Therapy: all forms of planned or intentional human-nature connections for promoting health, including Forest Bathing, Shinrin Yoku, Horticultural Rehabilitation, Outdoor Education, wilderness experiences (including hiking, camping, rock-climbing, biking), visits to local parks, urban gardening with a therapeutic focus, and other activities that intentionally connect humans with nature.
- Shinrin Yoku: Japanese practice of forest bathing, 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 Shugend Buddhist priests, or Yamabushi, of the

8th 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. (*3-Plevin_Forest_Bathing.Pdf*, n.d.)

EXHIBIT 2: INTERVIEW GUIDE (NATURE THERAPY FOCUS)

Review consent form; identity will be kept confidential; interview recordings will be destroyed at end of project

INTRODUCTION/BACKGROUND

- Focus of the study is to outline parameters of nature therapies that optimize BOTH health and environmental outcomes in the same space.
- Targeted Diseases: See PPT on targeted diseases (focus on certain diseases).
- "Nature" in nature therapy: means either native habitat or spaces that exhibit key aspects of native habitat (including vertical structure, interaction diversity, biodiversity, healthy soils, carbon sequestration)

CAN YOU GIVE A QUICK SUMMARY OF THE GOALS OF YOUR NATURE PROGRAMMING?

Specifically, do your programs relate more to public health/wellness/disease prevention vs. disease treatment (and if the latter, which diseases)?

WHAT DOES IT TAKE TO GET OPTIMAL HEALTH EFFECTS FROM NATURE?

1. What are the features of nature space that seem most effective in promoting health (spatial feature, size, sounds, etc.)?
2. What kind of spaces (aspects of the space) are required for successful forest therapy/nature-based health treatments?
3. How many people can be in a space during a nature therapy for it to have intended effects – is there a "maximum occupancy" per area/square foot we can identify?
4. How long does it take before exposure has an effect on the body (in a given dosage) – how long for each visit and how many visits? Is there evidence that more repetitive exposure is more effective over time.
5. Duration of health effects – related to:
    1. Length and # of Visits
    2. Neighborhood Characteristics (and baseline experiences of individual)
6. Have you seen evidence that proximity (or a maximum distance from people's home or work) matters for health effects?
7. Does extent of health effect correlate to extent of change from daily baseline (i.e. is there more effect of forests on people with daily baseline of nothing; or on people who are generally exposed to nature but denuded nature or who don't take advantage of nearby nature
8. How much does cultural experience of and exposure to nature previously (i.e. how it translates in people's minds) affect their health response to nature therapies you observe or study
9. Types of programming – greater effectiveness of some kind of programming over others?

WHAT CAN WE "PROVE" (TO HEALTHCARE INVESTORS? TO PATIENTS?)?

1. Any evidence that nature therapy can eliminate or reduce hospital stays (one of highest healthcare cost items)?
2. Where do you see clear-cut health responses to nature – any overlap with targeted diseases?
3. Are you tracking health care outcomes in your programs?

SEEKING OUT RELATIONSHIPS WITH HEALTH CARE INVESTORS

1. How have you funded your nature programs thus far?
2. Have you ever approached health care investors (hospitals, hospital associations, etc.) for funding nature-based therapies?

WHAT'S ALREADY HAPPENING IN THE MARKET?

1. Consumer Market/Market Demand & Private Market Supply of Nature Therapy
    a. Who is using nature therapies and for what purposes?
    b. Distance radius around forest/native ecosystem for consumer/patient market
2. Any evidence that insurance companies are providing any coverage for insured to use nature therapy?

ISSUES IN THE STUDY OF HEALTH AND NATURE

How big of a problem are confounding factors in the study of nature's effects on health? What other challenges have you observed?

EXHIBIT 3: INTERVIEW GUIDE (HEALTHCARE FOCUS)

Review consent form: identity will be kept confidential; materials destroyed at completion

INTRODUCTION

DEL-MEM Program, Professional background

Questions are exploratory, not restrictive. Some questions may seem repetitive – they are designed to stimulate additional ideas. Any referrals to experts who specifically engage in this topic are welcome.

BACKGROUND

- Focus of the study is to outline parameters of nature therapies that optimize BOTH health and environmental outcomes in the same space – outside of hospital campuses (and in urban communities and neighborhoods – so large numbers of people can easily access them)
- Additional focus here is on private investment from the health care sector, rather than public sector funding.
- Targeted Diseases: See PPT on targeted diseases (focus on certain diseases).
- "Nature" in nature therapy: means either native habitat or spaces that exhibit key aspects of native habitat (including vertical structure, interaction diversity, biodiversity, healthy soils, carbon sequestration)

CAN YOU GIVE A QUICK SUMMARY OF YOUR ROLE IN THE HEALTHCARE SECTOR?

Specifically, do your programs relate more to public health/wellness/disease prevention vs. disease treatment (and if the latter, which diseases)?

A. Healthcare Insurance/Investment Companies/Payers:

A. Awareness
    a. Are you familiar with nature-based therapies?
    b. Are you familiar with the efficacy of nature-based therapies for treatment of: (i) mental illness, (ii) high blood pressure, (iii) diabetes, (iv) obesity, (v) heart disease, and other illness?
    c. Are you familiar with the efficacy of nature-based therapies as preventative care/use for public health purposes?
    d. Have you worked with organizations that provide nature-based therapy?

B. Motivation
    a. To what extent have your clients considered using nature-based treatments for improving the quality of patient care? (or to reduce expenditures?)
    b. If you have not considered it, what level of treatment efficacy would you need research to demonstrate before you would invest in the use of these treatments? (for example, if

you knew that nature therapies could reduce hospital stays in your patient population by 30%, would that interest you?)
        i. Evidentiary levels requirement – what evidence would you require in order to use nature therapy
    c. What financial criteria or return on investment do you require before you are willing to invest in treatment or public health options?
    d. Do the healthcare providers have ESG plans or investors with ESG plans? Would these ESG plans be served by promoting nature-based therapies?
    e. What else would convince you that making nature-based therapies available is a good idea for your healthcare network?

C. Funding Capability
    a. What organizations have sufficient capital to invest in land-based/place-based treatments?
    b. where does private healthcare sector funding go today? What are criteria for investment?

D. Barriers
    a. Are there top competing investment priorities that prevent investment in nature-based therapies?
    b. What are barriers to investment in land uses? Is there a lack of perceived need for privately owned forested lands?
    c. Are there legal restrictions that prevent you from making investments in land, natural restoration, and/or nature-based therapy?

WHAT KIND OF PROOF DO INVESTORS NEED?

1. Any evidence that nature therapy can eliminate or reduce hospital stays (one of highest healthcare cost items)?
2. Where do you see clear-cut health responses to nature – any overlap with targeted diseases?
3. Are you tracking health care outcomes in your programs?

SEEKING OUT RELATIONSHIPS WITH HEALTHCARE INVESTORS

4. Have you ever approached health care investors (hospitals, hospital associations, etc.) for funding nature-based therapies?
5. Are healthcare systems looking at nature and green infrastructure as healthcare treatment assets? What are impediments to delivering private funding at scale?

FUNDING INQUIRY AND REQUIREMENTS

1. What aspects of the property acquisition and management cycle are they funding? Why?
2. Will they fund restoration costs for lands owned by healthcare providers for nature therapy purposes?
    a. What corporate entities in healthcare sector have money to invest in medical treatments and which of those entities will benefit from improved patient health? (identified entities: “deep pockets”)

b. which are subject to limiting laws and regulations on where they can invest their money?
c. For deep pockets with money that could be invested in nature-based treatments, what are their chosen investment criteria and restrictions?
d. Identify legal/regulatory/financial barriers to using healthcare funding for urban forest networks

WHAT'S ALREADY HAPPENING IN THE MARKET?

3. Consumer Market/Market Demand & Private Market Supply of Nature Therapy
    a. Who is using nature therapies and for what purposes?
    b. Distance radius around forest/native ecosystem for consumer/patient market
4. Any evidence that insurance companies are providing any coverage for insured to use nature therapy?

EXHIBIT 4: FINANCIAL MODEL – COST ASSUMPTIONS AND SOURCES

NATURE THERAPY COST ASSUMPTIONS AND SOURCES

(based primarily on personal communications, including interviews, and informed by all data collected)

- Each NT treatment session assumed to be **1 hour**. Data suggests that sessions should be between 30 minutes – 2 hours, with 1 hour generally sufficient for optimal benefit. Determined based on personal communications with AR1, AR2, P2, and literature review.

- Each NT treatment session assumed to treat a **group of 20 people**. Data suggests NT groups are optimal between 5-30 people. Determined based on personal communications with AR1, AR2, P2, and literature review. Note that the model assumes only 1 group of 20 people are in the ½ acre space at a time; whereas, it may be possible to run 2 separate NT treatment programs in the ½ acre space (with 20 people in each program) at the same time.

- Participants/patients assumed to attend 1-hour group sessions **three times per week**. Data suggests frequency should be at least once per week, but optimal frequency is more. So, appropriate range is likely 1-5 sessions/week/person. Determined based on personal communications with AR1, AR2, P2, and literature review.

- Participants/patients assumed to receive NT treatment **for 6 months**.[17] This assumption has the least amount of data to inform an appropriate range. Length of treatment in practice is exceptionally wide-ranging, and duration of health benefit post-treatment is largely unstudied. Given the high weekly frequency, the analysis assumes 6 months is sufficient. However, 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.

- This model assumes the cost of NT is effectively the cost of a trained nature therapist and uses a rate equal to $35/hour per a group of 5 people. Very little public data exists for this cost. This hourly rate is based on personal communications with P4. In addition, since the model assumes groups of 20 people, it uses an NT hourly rate of **$140/hour** (i.e., $35 x 4 groups of 5 people).

MEDICAL COST ASSUMPTIONS AND SOURCES

For medical expenditure data broken down by disease category, I used data from the federal Agency for Healthcare Research and Quality (at site: https://datatools.ahrq.gov/meps-hc#varexpLabel)

[17] Ending treatment at 6 months may be a problematic assumption, since treatment should occur on a regular basis over the long-term. However, financial feasibility requires treating higher numbers of patients than extended treatment periods may permit. There may be acceptable scenarios in which patients can pay a fee to continue receiving NT treatments after the 6-month period ends.

- Primary assumption in the model is the average cost per patient for cardiovascular disease. This figure was $5,691 per person in 2019. This per-person number was then aggregated for groups of 20 people.

- Third-party healthcare payers were assumed to cover 80% of these costs, which were then treated as the relevant healthcare expenditures.

CAPITAL INVESTMENT COST ASSUMPTIONS AND SOURCES

- Costs of initial investment
    1. Land acquisition: $23/square foot is assumed in the model for vacant land in Washington, D.C.-Baltimore-Virginia region. Source: Real Capital Analytics, Inc. 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. *Note: that the cost of the initial investment can increase to well over $1,000,000 for the ½ acre parcel (and up to ~$75/sf) so long as net cost savings remain near 20%* (see Exhibit 5).

    2. Costs of tree planting/forest regeneration/installation: $2.35/square foot for site preparation, planting, staking, and early maintenance costs. Cost assumption sources from personal communications with members of the Maryland Executive Directors of Land Trusts listserv, October 29, 2021 – November 1, 2021.

    3. Costs of design and Installation: financial model assumes cost of $3.42/square foot for design and installation. Note: 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 above for discussion of sensitivity analysis. Source: based on author's professional experience with projects through Urban Ecosystem Restorations (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.

- Annual Operating and Maintenance Costs. Note: because annual operating and maintenance costs are highly variable and property specific, sensitivity analysis was performed on these costs.

    1. Insurance: $0.22/sf, based on author's professional experience with projects through Urban Ecosystem Restorations.

    2. Taxes: $0.22/sf, based on author's professional experience with projects through Urban Ecosystem Restorations.

    3. Maintenance and property management: $1/sf. This number will be highly 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.

Cost Saving Scenarios from Financial Model

40% Scenario

Partial Replacement Cost Scenario								
1/2 acre scenario	low cost investment = $28/sf	480 people/year	10% discount rate	3% growth rate				
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**terminal value - Year 6**
Initial Investment	($609,840.00)							
Nature - cost of care (column C...)		262,080.00	269,942.40	278,040.67	286,381.89	294,973.35	303,822.55	9,533,900.33
Nature - cost of O&M		53,143.20	54,737.50	56,379.62	58,071.01	59,813.14	61,607.53	
(40%) Avoided Conventional Costs (to insurer)		874,137.60	900,361.73	927,372.58	955,193.76	983,849.57	1,013,365.06	
Net Avoided Costs (to insurer)	-$609,840.00	558,914.40	575,681.83	592,952.29	610,740.86	629,063.08	647,934.97	
							9,533,900.33	
Net Annual Revenues	-$609,840.00	$558,914.40	$575,681.83	$592,952.29	$610,740.86	$629,063.08	$10,181,835.30	
Initial Investment per sf (PV)	$28.00							
NPV (1/2 acre) - w/terminal value	$7,374,651.43							
NPV per SF - with terminal value	$169.30							
IRR	112%							
Discount Rate	10.00%							
Growth Rate (treatment expenses)	3.00%							
Growth Rate (stable - terminal value)	2.00%							
% Conventional Costs Avoided	40.00%							
FV of initial investment in Yr 6	1,080,368.76							
% of CVD costs covered by private insurance	80.00%							

PV of cash flows (@40% avoid) with terminal value	**$7,984,491.43**	**PV per sf**	**$366.60**	**(max/sf initial investment) (FV=PV (with 10% return))**

Initial Investment Sensitivity	Initial Investment	NPV w/ terminal value		
		$7,374,651.43		7,374,651.43
	($609,840.00)	7,374,651.43	0.40	7,374,651.43
Initial investment increased at 10%	($670,824.00)	7,313,667.43	0.30	4252731.429
	($737,906.40)	7,246,585.03	0.20	-1991108.571
	($811,697.04)	7,172,794.39	0.10	-11356868.57
	($892,866.74)	7,091,624.68	0.00	-23844548.57
	($982,153.42)	7,002,338.01		
	($1,080,368.76)	6,904,122.67		

30% Scenario

Partial Replacement Cost Scenario		Annual Operating/Treatment Costs-->						
1/2 acre scenario	low cost investment = $28/sf	480 people/year	10% discount rate	3% growth rate				
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**terminal value - Year 6**
Initial Investment	($609,840.00)							
Nature - cost of care (begins column C...)		262,080.00	269,942.40	278,040.67	286,381.89	294,973.35	303,822.55	5,806,164.58
Nature - cost of O&M		53,143.20	54,737.50	56,379.62	58,071.01	59,813.14	61,607.53	
(30%) Avoided Conventional Costs (to insurer)		655,603.20	675,271.30	695,529.43	716,395.32	737,887.18	760,023.79	
Net Avoided Costs (to insurer)	-$609,840.00	340,380.00	350,591.40	361,109.14	371,942.42	383,100.69	394,593.71	
							5,806,164.58	
Net Annual Revenues	-$609,840.00	$340,380.00	$350,591.40	$361,109.14	$371,942.42	$383,100.69	$6,200,758.29	
Initial Investment per sf (PV)	$28.00							
NPV (1/2 acre) - w/terminal value	$4,252,731.43							
NPV per SF - with terminal value	$97.63							
IRR	79%							
Discount Rate	10.00%	All equity - 15%						
Growth Rate (treatment expenses)	3.00%							
Growth Rate (stable - terminal value)	2.00%							
% Conventional Costs Avoided	30.00%							
FV of initial investment in Yr 6	1,080,368.76							
% of CVD costs covered by private insurance	80.00%							

PV of cash flows (@30% avoid) with terminal value	**$4,862,571.43**	**PV per sf**	**$223.26**	**(max/sf initial investment) (FV=PV (with 10% return))**

Initial Investment Sensitivity	Initial Investment (increasing)	NPV w/ terminal value		Discount Rate increasing	NPV w/terminal value
		$4,252,731.43			4,252,731.43
	($609,840.00)	$4,252,731.43		10.00%	4,252,731.43
Initial investment increased at 10%	($670,824.00)	$4,191,747.43		11.00%	$3,644,910.00
	($737,906.40)	$4,124,665.03		12.00%	$3,172,160.00
	($811,697.04)	$4,050,874.39		13.00%	$2,793,960.00
	($892,866.74)	$3,969,704.68		14.00%	$2,484,523.64
	($982,153.42)	$3,880,418.01		15.00%	$2,226,660.00
	($1,080,368.76)	$3,782,202.67		16.00%	$2,008,467.69

20% Scenario

Partial Replacement Cost Scenario		Annual Operating/Treatment Costs-->						
1/2 acre scenario	low cost investment =$28/sf	480 people/year	10% discount rate	3% growth rate				
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**terminal value - Year 6**
Initial Investment	($609,840.00)							
Nature - cost of care (column C...)		262,080.00	269,942.40	278,040.67	286,381.89	294,973.35	303,822.55	2,078,428.84
Nature - cost of O&M		53,143.20	54,737.50	56,379.62	58,071.01	59,813.14	61,607.53	
(20%) Avoided Conventional Costs (to insurer)		437,068.80	450,180.86	463,686.29	477,596.88	491,924.78	506,682.53	
Net Avoided Costs (to insurer)	-$609,840.00	121,845.60	125,500.97	129,266.00	133,143.98	137,138.30	141,252.45	
							2,078,428.84	
Net Annual Revenues	-$609,840.00	$121,845.60	$125,500.97	$129,266.00	$133,143.98	$137,138.30	$2,219,681.28	
Initial Investment per sf (PV)	$28.00							
NPV (1/2 acre) - w/terminal value	$1,130,811.43							
NPV per SF - with terminal value	$25.96							
IRR	37%							
Discount Rate	10.00%	All equity - 15%						
Growth Rate (treatment expenses)	3.00%							
Growth Rate (stable - terminal value)	2.00%							
% Conventional Costs Avoided	20.00%							
FV of initial investment in Yr 6	1,080,368.76							
% of CVD costs covered by private insurance	80.00%							
PV of cash flows (@20% avoid) with terminal value	**$1,740,651.43**	**PV per sf**	**$79.92**	**investment) (FV=PV (with 10% return))**				

Initial Investment Sensitivity	Initial Investment	NPV w/ terminal value
		$1,130,811.43
	($609,840.00)	1,130,811.43
Initial investment increased at 10%	($670,824.00)	1,069,827.43
	($737,906.40)	1,002,745.03
	($811,697.04)	928,954.39
	($892,866.74)	847,784.68
	($982,153.42)	758,498.01
	($1,080,368.76)	660,282.67

15% Scenario

Partial Replacement Cost Scenario								
1/2 acre scenario	low cost investment =$28/sf	480 people/year	10% discount rate	3% growth rate				
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**terminal value - Year 6**
Initial Investment	($609,840.00)							
Nature - cost of care (column C...)		262,080.00	269,942.40	278,040.67	286,381.89	294,973.35	303,822.55	214,560.96
Nature - cost of O&M		53,143.20	54,737.50	56,379.62	58,071.01	59,813.14	61,607.53	
(15%) Avoided Conventional Costs (to insurer) - NT treatment effect		327,801.60	337,635.65	347,764.72	358,197.66	368,943.59	380,011.90	
Net Avoided Costs (to insurer)	-$609,840.00	12,578.40	12,955.75	13,344.42	13,744.76	14,157.10	14,581.81	
							214,560.96	
Net Annual Revenues	-$609,840.00	$12,578.40	$12,955.75	$13,344.42	$13,744.76	$14,157.10	$229,142.78	
Initial Investment per sf (PV)	$28.00							
NPV (1/2 acre) - w/terminal value	-$430,148.57							
NPV per SF - with terminal value	($9.87)							
IRR	-12%							
Discount Rate	10.00%		Positive NPV at 5% discount rate					
Growth Rate (treatment expenses)	3.00%							
Growth Rate (stable - terminal value)	2.00%							
% Conventional Costs Avoided due to NT	15.00%							
FV of initial investment in Yr 6	1,080,368.76							
% of Conventional Costs paid by private health insurance	80.00%	80% coverage of costs is standard after considering deductibles, copays, coinsurance, and premiums						
PV of cash flows (@15% avoid) with terminal value	**$179,691.43**	**PV per sf**	**$8.25**	**(max/sf initial investment) (FV=PV (with 10% return))**				

Initial Investment Sensitivity	Initial Investment	NPV w/ terminal value
		-$430,148.57
	($609,840.00)	(430,148.57)
Initial investment increased at 10%	($670,824.00)	(491,132.57)
	($737,906.40)	(558,214.97)
	($811,697.04)	(632,005.61)
	($892,866.74)	(713,175.32)
	($982,153.42)	(802,461.99)
	($1,080,368.76)	(900,677.33)