Linking Science — Measuring Health Outcomes

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“If you don’t count, you don’t count.”
— Peter Harnik, TPL

This chapter is intended to provide a starting point for a much larger discussion among land conservationists, health care practitioners, researchers and funders about how to move forward in connecting health and nature. It focuses on the key questions of:

• Why measure the impacts of nature on health?
• What might or should we be measuring?
• What is already being done to measure the connections between nature and health?
• What are the challenges to accurate measurement?
• What are some of the most promising solution spaces and datasets to explore for the future?

While this paper is not by any means a comprehensive analysis of these issues, it aims to create a common understanding of the work to date and propose directions for future efforts.

3.1 Why Measure? The Challenge of Proof

In today’s world, people are feeling the effects of a life that has become too sedentary, too digitalized and too much spent indoors. In response, there has been a movement to bring nature back into our lives. Across the country, intentionally designed healing gardens, wild and winding trail systems, comprehensive experiential education for children and adults,
and other initiatives to get people back outdoors are all growing. But once we get people out there, then what? How will we know if it is making a difference?

We know instinctively that people who spend time outdoors are typically more fit, more physically active and often happier than people who spend all their time locked up indoors. However, we have lacked a comprehensive body of evidence that links nature to health (Mowen, conversation with author, March 19, 2014). Now, a new generation of research that substantively demonstrates such effects is expanding, driven by a demand for evidence-based policy-making and by funding that looks to leverage these benefits for three main goals:

• Lowering healthcare costs while improving access to and quality of care.

• Addressing and mitigating costs of health and social inequities.

• Creating broader constituencies for land conservation.

In the past, much of the evidence linking nature and health was anecdotal, focusing on perceived impacts. Self-reporting and direct observation are still some of the most cost-effective and feasible ways of measuring the impacts of nature on health, but some researchers are now experimenting with quantitative measurements like skin conductivity, cortisol levels, and blood pressure.

Much like the alternative health and medicine movement, which has gained currency in recent years through studies measuring its health outcomes, the effects of nature on health are increasingly being documented in systematic and scientifically rigorous ways (Berkley, conversation with author, February 15, 2014). A suite of powerful new technology and mapping tools is rapidly developing in directions that could aid this movement.

Gathering health outcome data from exposure and access to natural areas, however, poses significant logistical and practical challenges, and many of these studies are still in their nascent stages. With limited resources available, practitioners in this field need to figure out what to measure and how to do it efficiently. How can we ensure that data collection is intentional and policy-directed? How can we prioritize funding for research in this area? What sort of data is still needed to conclusively demonstrate positive effects? And how will this data be translated into prevention and treatment regimes that can be enacted soon, so that as many people as possible may maximize benefits from them?

Ultimately, research and measurement in this field should be directed towards scaling up. We want to know how to measure the impacts of nature not only on the health of individuals, but also the cumulative impacts of landscape level planning on communities, regions, and cities.

Some of these nature-based health solutions may offer treatment for illnesses or chronic conditions, but their real strength likely lies in preventive care. As more of the health care system shifts toward prevention, regimes of time spent outdoors seem particularly promising for improving health and reducing disease.

Funders, hospitals, and government entities are looking to invest in policies or infrastructure that will have a big “bang for the buck,” affecting the health and behavior of many people.
They are interested in the cost-effectiveness of health solutions, with a heavy emphasis on getting results. Measurement should thus be focused toward compiling actionable evidence that is compelling enough to be translated into changes in health business models. The chains of causality that lead from natural areas to improved human health must be as clearly defined and well-understood as possible. At the same time, as new initiatives are created, it is critical to direct funding to the right places – supporting what’s working and changing what’s not.

**Pathways to Health**

If we are to optimize funding and focus research, we must better understand the mechanisms that connect health and nature. A 2014 paper published by Hartig et. al. in the *Annual Review of Public Health* suggests four commonly recognized pathways. Figure 1):

![Four Pathways by which the Natural Environment can Affect Human Health](image-source)

These pathways (air quality, physical activity, social cohesion, and stress reduction) and their implications for measurement methodologies will be discussed at greater length later in this chapter, but for the moment, they provide a basic framework from which to start thinking about measurement.

As the paper’s authors note, however, “the mechanisms by which nature might affect health are multiple and synergistic,” and effects vary across different population subgroups, in dif-
different contexts, and across spatial and temporal scales (Hartig et al. 2014). In addition, it will be critical to not only examine the effects of the presence of nature, but also of its absence in human lives. These consequences may be just as persuasive.

Throughout the research process, approaches must be drawn from multiple disciplines. The very first step may be to define “nature” or “health” in standardized terms that are mutually recognizable and comparable. Such definitions may tap into urban planning, epidemiology, ecology, psychology, or other fields. The next steps will be to determine the metrics, qualitative and quantitative, with which to delineate categories and track impacts, then to collect and analyze data at different scales. Findings will need to be further examined through the cost-benefit and cost-effectiveness perspective of health care economics, and through the lens of social and health equity. Finally, conclusions need to make their way back into policy and practice through avenues like evidence-based design, better funding and management of parks, and improved access to private conserved land. Collaborations are key to this research, facilitating the collection, management, and sharing of data between scientific experts, users, and other stakeholders.

**Dividing up Roles and Responsibilities for Measurement**

This paper’s primary audience is land trusts, foundations, and healthcare providers. To that end, it focuses on the capacities and strengths of these actors, and looks for synergies among them.

The diagram below suggests some preliminary ways these groups might divide up measurement, but with new developments in research these responsibilities might be reallocated in ways that make more sense or maximize efficiency.
For healthcare organizations looking to reduce costs and improve patient outcomes, gathering data on health and disease consequences of time outdoors could help optimize treatment. For example, obesity and diabetes is an obvious and very measurable area where improved access to the outdoors could provide a cost-effective solution. A 2006 study showed that a person with obesity spends on average $1,429 more per year on health care than a person of normal weight and these costs are rising (CDC, 2012a).

Increased physical activity, a strong corollary of access to open space, is an excellent way to both treat and prevent obesity and diabetes. In addition, the outdoors environment may also have other, more subtle benefits for health. Both healthcare providers and insurers are well-positioned to track such data for their patients and clients, while foundations might be better suited to analyzing large datasets at a population scale.

In the realm of health and social equity, measurement is a way for funders or healthcare organizations to identify critical gaps – such as the inequitable access to parks in certain cities or neighborhoods that has been called a “new dimension for environmental justice” (Strife and Downey 2009). Likewise, measurement and mapping of health care access or disproportionate rates of chronic disease may reveal areas that might particularly benefit from increased green space or outdoors initiatives.

While such initiatives are not a substitute for improved health care systems, they are a way to support and enhance improvements. With the advent of the Affordable Care Act, Community Health Needs Assessments (CHNAs) are becoming a crucial tool for many hospitals to establish a baseline and develop strategies to address local needs. Funders or government agencies looking to maximize their social impact will need to refine and test the use of specific health indicators to monitor and evaluate their impacts on their target communities.

As the proprietors of open space, land trusts and park agencies are well positioned to gather data on usage and land attributes that may ultimately lead to better management and more funding. While they often lack the staff and resources to systematically gather this information, opportunities exist for collaboration among foundations, hospitals, and land trusts that better supports the collection of relevant data and ties it into health information being managed by health care organizations.

And for land trusts, a better understanding of the connections between health and nature may be critical to survival in the future. U.S. Census numbers predict that by 2050, the majority of the U.S. population will be non-white. Accordingly, conservation organizations across the country have realized that they need to expand the demographics of their movement and broaden their appeal to become more relevant to those outside the “traditional” conservation community (Forbes, 2011). Partnerships that measure the value of conserved land and green space for health will help maintain funding and political support for these places, even through difficult economic times.

According to William Bird of the organization Natural England, “we can make a good case right now for land conservation based on its benefits to human health. The true question now is how to make this case more robust.” (Bird, telephone interview with D.Krause, 2014)
3.2 What Should We Be Measuring?

Determining health outcomes from time spent outdoors is complicated by the intertwined and confounding nature of the variables to be measured. This section attempts to break the questions of measurement into six separate categories:

- What type of exposure or use?
- To what kind of nature?
- For whom and at what scales?
- To address what needs?
- With what outcomes or effects?
- Using what tools or methodologies?

The chart below highlights some of the key types of data that might be collected for each of the six categories. Each category is then discussed in the sections that follow.

<table>
<thead>
<tr>
<th>Exposure and Use</th>
<th>Natural Environments</th>
<th>Target Populations</th>
<th>Needs Assessment</th>
<th>Outcomes and Effects</th>
<th>Measurement: Tools and Methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity</td>
<td>Types of trails</td>
<td>Individual health vs epidemiology and community health</td>
<td>Proximity to green space</td>
<td>Caloric output</td>
<td>Direct Observation</td>
</tr>
<tr>
<td>Access</td>
<td>Park facilities/ features/ size/ programming</td>
<td>Vulnerable populations (underserved, low income)</td>
<td>Chronic health issues</td>
<td>Test performance</td>
<td>Self-reporting</td>
</tr>
<tr>
<td>Use</td>
<td>Public or Private land</td>
<td>Pregnant women</td>
<td>Community Health Needs Assessment</td>
<td>Social Cohesion</td>
<td>Individual surveys</td>
</tr>
<tr>
<td>Visitation</td>
<td>Urban parks vs Wilderness</td>
<td>Children/ youth</td>
<td>Income, race, age</td>
<td>Stress Reduction</td>
<td>Interviews</td>
</tr>
<tr>
<td>Statistics</td>
<td>Scale and “naturalness”</td>
<td>Obese and diabetic</td>
<td>Accessibility and programming</td>
<td>Physical activity</td>
<td>Phone surveys</td>
</tr>
<tr>
<td>Physical activity</td>
<td>Vegetation &amp; Greenness</td>
<td>Preexisting substance abuse/mental health issues</td>
<td>Equity</td>
<td>Toxics/ pollutants</td>
<td>Mapping</td>
</tr>
<tr>
<td>Intensity of</td>
<td>Tree cover</td>
<td>Veterans</td>
<td></td>
<td>Air quality</td>
<td>Direct measurement (BP, cortisol, etc.)</td>
</tr>
<tr>
<td>activity</td>
<td></td>
<td>Patients with chronic or acute disease</td>
<td></td>
<td>Wellbeing</td>
<td>Psychological tests</td>
</tr>
<tr>
<td>Recreation</td>
<td></td>
<td></td>
<td></td>
<td>Mortality/ illness</td>
<td>Health indicators</td>
</tr>
<tr>
<td>Work/leisure</td>
<td></td>
<td></td>
<td></td>
<td>Reduced costs?</td>
<td>Health care costs and utilization data</td>
</tr>
<tr>
<td>Outdoor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Emergency room visits</td>
</tr>
<tr>
<td>education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mixed methodologies</td>
</tr>
<tr>
<td>Wilderness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>therapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2.1 Exposure and Use

When we are looking at the “dosage” of time spent outdoors, it is important to distinguish between proximity, access, and use, all of which are parallel but not interchangeable concepts. Additionally, we should be thinking of what characterizes “exposure” and how long we have to be exposed to nature to feel an effect. What is the role of active or passive use in mediating health effects, and as a corollary, what happens if we are not exposed to nature?
Finally, we may examine different types of use and characterize these through measurements of visitation or activity.

<table>
<thead>
<tr>
<th>EXPOSURE = DOSAGE X TIME?</th>
<th>WHAT KIND OF USE?</th>
<th>WHAT TO MEASURE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Visitation</td>
<td>· Education</td>
<td>· Intensity of activity</td>
</tr>
<tr>
<td>· Proximity</td>
<td>· Work</td>
<td>· Time spent</td>
</tr>
<tr>
<td>· Accessibility</td>
<td>· Resting/leisure activities</td>
<td>· Number of visits</td>
</tr>
<tr>
<td>· Use</td>
<td>· Active/passive</td>
<td>· Caloric expenditure</td>
</tr>
<tr>
<td></td>
<td>· Physical activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Therapy</td>
<td>· SOPARC (these metrics will be expanded on in section 3.2.6)</td>
</tr>
<tr>
<td></td>
<td>· Active transport (like biking or walking)</td>
<td></td>
</tr>
</tbody>
</table>

Hartig et al. (2014) identify three ways to measure the exposure of a study group to nature. These include:

· Assessing how much “nature” exists close to where they live;

· Surveying them to ask how much time or how often they actually spend time in nature; and

· Objectively measuring the time they spend outside using GPS technology.

Within each of these realms, we can also make further distinctions. Whereas proximity might only be a distance to the nearest park, measured using buffering tools in GIS software, other factors may also affect access and use. For example, Kuo (2010) notes that just because a park is nearby does not mean that it will be used if it is seen as unsafe. Factors affecting use include:

· Perceptions of safety in that space;

· Transportation barriers – like dangerous streets or lack of sidewalks; and

· Programming or facilities (such as play structures or sports fields) at the park that make it more or less appealing or usable.

“Use” as a concept may be split into additional categories of work or leisure, and into varying types and intensities of physical activity. These variables are relevant because they allow us to distinguish between a park user sitting on a bench reading a book, and one running or playing an active sport, each of which may have different mental and physical health consequences.
Researchers have come up with several methodologies, such as the “SOPARC” method, which enables a blend of qualitative and quantitative assessments of park use. At the same time, however, it remains difficult to distinguish between health effects directly attributable to nature, and those that are a consequence of the physical activity itself.

An additional category of “use” is worth mentioning, as it provides a fruitful area for research: outdoor and experiential education. Outdoor education is a broad term that might be used to describe anything from an hour-long natural history class in an elementary school yard, to a multi-month wilderness experience for troubled teens. This wide range brings up the second category of measurement.

### 3.2.2 Natural Environments: The Green Spectrum

What kind of nature and what types of open space can produce desired health benefits? Vegetation and greenness are measures that have been used to demonstrate health effects like reduced post-surgery recovery times in patients whose windows provided natural views (Ulrich, 1984) or short-term changes in mental status or attention after viewing natural scenes (Kuo, 2010).

On a broader scale, however, it remains to be seen what attributes of landscapes create long-term effects on health. The type, location, and quality of the outdoors have implications for how and why it is used by people. One aim of this paper is to increase research and data collection on private land, but the bulk of research so far has taken place on public land, and differences in management of public and private land should be considered in the design of future studies.

Open space also comes with varying levels of “naturalness” and in different scales, from tiny urban pocket parks to immense national forests. A measure of proximity might show that there were multiple pocket parks in a downtown area, but the carrying capacity of these places might be much smaller than for a large parcel of open space (Robertson, conversation with author, April 14, 2014).

The chart below provides some suggestions for how land trusts and researchers might describe the type of nature they are investigating:
<table>
<thead>
<tr>
<th>TYPE OF NATURE</th>
<th>CHARACTERISTICS AND FEATURES</th>
<th>WHAT TO MEASURE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Public/private land</td>
<td>• Infrastructure</td>
<td>• “Greenness”</td>
</tr>
<tr>
<td>• Urban parks and greenways</td>
<td>• Sports facilities &amp; playgrounds</td>
<td>• Tree cover</td>
</tr>
<tr>
<td>• Suburban protected areas</td>
<td>• Barriers to access</td>
<td>• Species diversity/type of vegetation</td>
</tr>
<tr>
<td>• Yards and gardens</td>
<td>• Safety</td>
<td>• Familiarity of landscape</td>
</tr>
<tr>
<td>• Rural/agricultural land</td>
<td>• Programming</td>
<td>• Size</td>
</tr>
<tr>
<td>• Wilderness areas</td>
<td>• Atmosphere of park</td>
<td>• Naturalness/amount of development</td>
</tr>
<tr>
<td>• Ecosystem type</td>
<td>• Signage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Trail difficulty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surrounding community design</td>
<td></td>
</tr>
</tbody>
</table>

Parks are at the forefront of the research in this field, with novel partnerships between organizations like the RAND Corporation and the City Parks Alliance leading the charge.

**Assessing Parks in the US: City Parks Alliance and the RAND Corporation**

The City Parks Alliance and the RAND Corporation have teamed up to conduct a four-year, comprehensive assessment of physical activity and park management within 200 parks in 25 randomly selected cities around the US. It is one of the largest systematic park observation surveys ever initiated, and its detailed methodology strives for the sort of standardization that will make this data easily analyzable. The goal is ultimately to improve park management in ways that will facilitate and enhance physical activity.

Trained observers use a version of the SOPARC method (described in section 4.2.6) to note variables like number of people, type of activity, and intensity of physical activity in a park. Over the course of a week, they go out to gather data multiple times in a given park before moving on to the next one. In addition to physical activity, each park is described in terms of its neighborhood, physical structures, transportation access, condition and general atmosphere, and users are described in terms of their demographics. This information is input directly into iPads that upload to a central data management server for analysis (McHugh, conversation with author, 4/20/14).
Mapping and visualization technologies like aerial photography, along with remote sensing, Lidar and GIS software are all powerful tools in assessing the type of nature people are being exposed to at larger scales. However, all of these methods must be ground-truthed by researchers actually visiting the sites to verify that their remote observations of vegetation or tree cover are accurate and calibrated.

Ming Kuo at the University of Illinois Health and Landscapes lab has been conducting an ongoing longitudinal study using aerial photographs of schools to assess changes in levels of “greenness” over time, and to see how these levels correlate with changes in standardized test scores (Kuo, conversation with author, April 26, 2013). Tree cover, estimated using publicly accessible datasets and Lidar technology, has also been employed by some researchers, such as Bill Sullivan (also of the University of Illinois), in city-wide studies that look at its correlation with other variables such as social capital (Holtan et al., 2014).

Urban forests and their benefits may also be measured down to the level of individual trees, as the USDA’s iTree tool does.

Managing Urban Forests

The iTree tool is an online tool that can be used as a benefits calculator for street trees in urban areas. At this time, it does not include health benefits in its analyses, but these could be incorporated in a later iteration.

For more information see: [http://www.itreetools.org/streets/index.php](http://www.itreetools.org/streets/index.php)

Land trusts and others interested in connecting natural areas and health should seek to create standard measurements that both quantify and describe natural spaces in terms of multiple variables like the ones considered above.

### 3.2.3 Target Populations

As we study health outcomes, it is important to know for whom we are measuring impacts and at what scale. Both the effects of contact with nature and the ways in which it is used could vary widely depending on who we are looking at. For example, different cultural groups may use parks in distinct ways – for picnics and family gatherings in some cases, for solitude and exercise in others. The impacts may also differ by age or health status – adults might benefit from different levels of physical activity than children, and preexisting conditions like heart disease or mental illness might amplify or decrease these impacts.
In order to better target interventions to address those with the greatest health needs, we need to focus on “vulnerable” populations to determine if nature is actually an effective way of treating them. Gathering demographic information is thus a key part of measurement.

A few of the variables discussed above are considered in the chart below:

<table>
<thead>
<tr>
<th>EFFECTS AT WHAT LEVEL?</th>
<th>POPULATION SUBGROUPS</th>
<th>“VULNERABLE” POPULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Individual</td>
<td>• Healthy adults</td>
<td>• Underserved communities</td>
</tr>
<tr>
<td>• Family</td>
<td>• Children/youth</td>
<td>• Obese and diabetic</td>
</tr>
<tr>
<td>• Population group</td>
<td>• Pregnant women</td>
<td>• Other chronic disease</td>
</tr>
<tr>
<td>• Community</td>
<td>• Ethnic/racial/cultural groups</td>
<td>• Substance abuse/mental health problems</td>
</tr>
<tr>
<td>• City or county</td>
<td>• Urban/rural</td>
<td>• Veterans</td>
</tr>
<tr>
<td>• Region</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As a group with many mental and physical health needs, veterans are good candidates for therapeutic use of outdoor activity.

**Veterans and the Outdoors**

The R4 Alliance is a consortium of outdoor groups who provide recreation and therapy to military veterans. Its members seek to use the “healing power” of nature and outdoor recreation to support military families.

While one of the “R’s” listed in its name stands for “Research,” R4’s website notes: “While few doubt the positive impacts our member’s programs have on the lives of Our Military Family, we lack a homogeneous body of evidence to prove our efficacy and drive evidence based practices. In order to prove the benefit of these services and gain recognition in the medical community, we as an industry need to collaborate our research efforts to gain the body of evidence needed to prove the efficacy our services.”
This statement highlights the key issue in measurement of the connections between health and the outdoors: while most people agree that there are benefits to this exposure, the burden of proof is still on those who advocate for more time in nature.

The Sierra Club’s Military Outdoors program is a member of the R4 Alliance. It organizes trips providing service members with outdoor experiences. In collaboration with the University of California at Berkeley, the program is in the process of initiating a three-year longitudinal study of resilience related to veterans’ outdoor experiences.

For more on these topics see: The R4 Alliance: http://r4alliance.org/research/ and http://r4alliance.org/wp-content/uploads/2014/05/SIERRA_REPORT_6_13_Exploring-the-benefits-of-outdoor-experiences-on-veterans.pdf

Sierra Club Military Outdoors: http://content.sierraclub.org/outings/military

Other groups looking to improve the health of particular populations might use the R4 model to drive research investigating the effects of nature on their constituents, ensuring that their work is indeed effective in serving them.

### 3.2.4 Needs Assessments

Even before developing interventions, it is critical to focus attention on measurement of areas with the highest need for green space. Mapping is a powerful tool both for needs assessment and analysis. Breece Robertson, head of the GIS program at the Trust for Public Land (TPL), has been involved in creating a number of planning and assessment resources.

#### ParkScore

The Trust for Public Land (TPL) developed the ParkScore Index for the 50 largest U.S. cities. Using a combination of mapping tools and demographic data, TPL analyzed each city and gave it a score based on how well each city is meeting its population’s need for parks.

Points were given based on three main criteria: acreage, services and investment, and access. Acreage was calculated from two equally weighted measures: median park size and park area as a percentage of total city area. Services and investment were likewise calculated from number of playgrounds per resident and spending per resident, and access was based on the percentage of population within an unimpeded ten-minute walk of a park. Park need was also assessed based on U.S. Census data like “percentage of population 19 or younger” and “households with median income less than 75% of city median income.”
The interactive ParkScore tool serves as an accessible gateway for both practitioners and the public to access and easily visualize information. Users can look at city rankings, individual variables, and map indicators like childhood obesity.

See Chapter 2 for more information on how ParkScore has been applied in Houston.

Image courtesy of the Trust for Public Land: http://parkscore.tpl.org/

In addition to ParkScore, TPL has led the way in designing and applying a number of other tools. For example, it works with city parks departments to study and increase equity in access to parks. This involves creating buffers around parks or using a network analysis tool to look at the actual pathways and roads that people take to access parks, then layering this with demographic data on income, housing, age, and other factors to analyze the need for open space in certain areas. This is the ParkServe tool. (for more information on the use of this tool see Section 2.3)

TPL is also working on a model that considers the carrying capacity of parks based on their size and facilities and a Park Access Indicator that will link the ParkScore and ParkServe tools. The Park Evaluator tool is a geodesign tool that can run calculations on what the impact of a park would be if it was put in a certain location. While this allows planners to evaluate individual parks, work still remains to assess park systems as a whole.

After parks are constructed or renovated, TPL and the City Parks Alliance plan to monitor the outcomes, and TPL is working with the Robert Wood Johnson Foundation to look at how the placement of parks might affect people’s health. To this end, they are interviewing individual park users to gather demographic data on their age, ethnicity, and health, with the intention of conducting follow up interviews with these same users to see if their health data changes over time. Most of these studies are still in their early stages, but in the future TPL hopes to be able to publish their findings (Robertson, conversation with author, April 14, 2014).

A partnership between these three organizations led to a comprehensive assessment of children’s need for access to green space in Kalamazoo, Michigan.

A vulnerability index was created based on demographic variables such as income, race, and age. This was combined with buffering projected out from existing parks, playgrounds, and recreational open space to assess which areas were more than a ten-minute walk from green space.

The study’s findings identified high-priority areas for targeting children’s outdoors initiatives. The maps generated also helped inform future city planning in Kalamazoo, a fine example of the power of maps for linking information to place.

For more information on this project see: [http://cloud.tpl.org/pubs/convis-kalamazoo.pdf](http://cloud.tpl.org/pubs/convis-kalamazoo.pdf)

3.2.5 Outcomes and Effects: Treatment vs. Prevention

“We’re moving from sick care to health care.”

— Marydale Debor, Connecticut Mental Health Center

Human wellness and health consists of multiple dimensions, ranging from happiness and satisfaction, to the absence of disease. Therefore, when looking at health outcomes from time in nature, a number of theoretical questions must be asked. These include:

- How does one tease apart complex health outcomes to find compelling evidence of a “nature effect”?
- How are behavioral changes that lead to better health outcomes, like increased physical activity, related to time spent outdoors? And how does one distinguish the impacts of physical activity from the impacts of nature?
- What changes are we measuring and from what baseline?
- Are we talking about treatment or prevention, and is one case more compelling than the other?
- What level of impact are we looking at in terms of public health?
- Are there models from other fields besides public health that will be useful for tracking outcomes?
• Are there differential effects for vulnerable populations?
• What are the pathways by which these beneficial effects work?

While some might see the effects of nature on health as “unstudyable,” reviews of alternative medicine practices may offer some basic guidelines for determining health impacts. In alternative medicine, it is useful to break down the “effect” into different components such as “relationship between the user and practitioner” or “the techniques used to enhance the healing process” (Long, 2002). For nature, these categories might correspond to the type of natural area a person interacts with or what activity they pursue outdoors. Encouragingly, researchers of alternative medicine insist that “established methodologies (e.g., experimental trials, observational epidemiology, social survey research) and data-analytic procedures (e.g., analysis of variance, logistic regression, multivariate modeling techniques) are entirely sufficient to both assess the effectiveness of interventions and explore the pathways by which they work” (Levin et al., 1997).

This is likely true of nature as well. The challenge, then, is to figure out where to look for effects and how to develop qualitative and quantitative measurements for them.

Some components of health that may be affected by nature are summarized in this chart. They will be further expanded upon below.

<table>
<thead>
<tr>
<th>PHYSICAL HEALTH</th>
<th>MENTAL HEALTH</th>
<th>SOCIAL CAPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Physical activity/Behavior</td>
<td>• Resilience</td>
<td>• Social cohesion</td>
</tr>
<tr>
<td>• Body Mass Index (BMI)</td>
<td>• Depression</td>
<td>• Collective efficacy</td>
</tr>
<tr>
<td>• Presence/absence of disease</td>
<td>• Stress</td>
<td>• Social control</td>
</tr>
<tr>
<td>• Need for medications</td>
<td>• Wellbeing</td>
<td></td>
</tr>
<tr>
<td>• Stress effects</td>
<td>• Self-concept/self-esteem</td>
<td></td>
</tr>
<tr>
<td>• Pain</td>
<td>• “Life effectiveness”</td>
<td></td>
</tr>
<tr>
<td>• Obesity/Diabetes</td>
<td>• Self-control</td>
<td></td>
</tr>
<tr>
<td>• Respiratory/cardiovascular health</td>
<td>• Life attitudes</td>
<td></td>
</tr>
<tr>
<td>• Blood Pressure</td>
<td>• Happiness/satisfaction</td>
<td></td>
</tr>
<tr>
<td>• Hospital visits</td>
<td>• Cognitive function</td>
<td>• ADHD</td>
</tr>
</tbody>
</table>
Connecting Health to Nature

Contact with nature seems to have effects on physical health, mental health, social capital, general well-being, and even on cognitive performance. While many of these effects are positive, we must also consider possible negative effects, such as accidents or injury, or exposure to outdoor allergens and pathogens (Gentry et al., 2013).

In the past, much of the environmental health field focused on toxicity and pollution. These issues are still critical as we consider the effects of natural space and time spent outdoors for health. For one thing, since they tend to enclose sources of pollutants, indoor environments tend to be more toxic than outdoor ones (Godbey, 2009). In some cases, however, time spent playing outdoors may lead to greater exposure to pollutants, such as ozone on hot summer days in the city.

As outdoor air quality is already a commonly monitored variable with a large available dataset, it may be worthwhile to consider the interaction between vegetation and air quality, with resulting changes in air-quality-related health outcomes. While trees may be a source of allergens and hydrocarbons (Hartig et al., 2014), they also tend to sequester pollution, improving air quality. A 2013 study looked at tree loss due to the invasive Emerald Ash Borer beetle. Donovan et al. found a relationship between Ash tree loss and increased human mortality related to the presence of fine particulates that cause cardiac or lower respiratory tract disease (Donovan et al., 2013).

In addition to air quality, Hartig et al. cite three other main pathways that have been found to connect health and nature. Physical activity may have both physical and mental health effects. Safe, high quality, natural spaces can attract people outside and encourage more outdoors walking, active play, or “active transport” like walking or biking. At the same time, open spaces that encourage people to interact with each other may foster the building of relationships and a sense of community that has been proven to positively impact mental and physical health. Both of these pathways also contribute to reduction of stress. Contact with nature has been shown to reduce markers of chronic stress like cortisol, and to reduce illnesses associated with stress. It also may promote an increased “subjective well-being” both by creating distance from stressors like traffic or noise and by helping restore attention, cognitive function, and the ability to deal with stressful situations (Hartig et al. 2014).

These pathways intertwine in multiple ways, contributing overall to physical health, mental health, social cohesion, and the treatment and prevention of many illnesses.

Physical health effects from nature might manifest as changes in some of the following measurable indicators:

- Body Mass Index (BMI), a measure of body fat based on one’s height and weight (McCurdy et al., 2010)
- Blood Pressure and Heart Rate (Park et al., 2010)
- Pain (Malenbaum et al. 2008)
Detailed health status, which can include many variables and health indicators. (Berkley, conversation with author, February 15, 2014)

Mental Health effects may include changes in the following:

- Self-reported wellbeing. (Kellert and Derr, 1998)
- Stress indicators like salivary cortisol levels or skin conductivity. (Miller, 2012).
- Severity of ADHD symptoms. (Kuo & Faber Taylor, 2004)
- Mental resilience. (Wells and Evans, 2003)
- Happiness and satisfaction. (Kellert and Derr, 1998)
- Cognitive function. (Berman et al., 2008)
- Concentration and test performance. (Faber Taylor and Kuo, 2009)

More general effects on health or socialization include:

- Social Capital (Halton et al. measured this using a telephone survey and a questionnaire. Residents were asked to score seven statements about their neighborhood, including five related to neighborhood social cohesion and association.)
- Self-Concept. (Kellert and Derr, 1998)
- Behavioral or attitude change. (Sibthorp et al., 2008)
- “Life effectiveness,” which refers to “generic life skills which facilitate surviving and thriving across a variety of situations.” (Neill, 2008)

While health effects from nature are indeed complex, measurement by health care providers or researchers should endeavor to capture easily quantifiable variables like blood pressure or BMI, but should not ignore more qualitative ones like mental health, self-concept, and social efficacy.

3.2.6 Measurement: Tools and Methodologies

Perhaps the most critical question of all in this growing field of research is how to gather the data we are seeking. In addition to the health measures mentioned above, most research so far focuses on physical activity, park visits, and types of use, employing a combination of observational and self-reporting techniques like regular monitoring of parks, interviews, or surveys. Instrument-based measurements are also becoming more popular, although these studies are more difficult to conduct. (See Section 3.4 for more information on these challenges.)

Sarah Barbo, in her 2014 master’s thesis at the Yale School of Forestry and Environmental Studies looking at the correlation between health and nature, provides a useful matrix that sorts relevant studies according to their methodology (observed/measured or self-reported), and their health effect (physical or mental).
In general, different types of measurement may be sorted into observation, self-reporting, and measurement using external devices or tools, each of which is expanded upon below.

Observation can be conducted by researchers or through collaboration with trained lay people (Harnik, conversation with author, April 8th, 2014). Observers may use standardized forms that detail quantitative or qualitative information such as number of park users or the atmosphere of a park.

Self-reporting usually takes place through interviews, in-person surveys, or mail-in and telephone surveys. Surveys should be designed to allow for the management and comparison of data. Thus, they may include categorical, scalar, and open-ended questions on wellbeing, health status or preexisting conditions, amount and frequency of outdoor recreation, and on stress levels.

**Tools for Measuring Physical Activity:**

Physical activity measurement using external devices may be one of the most fruitful areas of research at this point. Simple, portable instruments like the following help facilitate the gathering of detailed information.
Accelerometers/odometers: These devices may be worn by subjects to measure the intensity of their physical activity outdoors (Cleland et al., 2008)

GPS: Global Positioning System devices or even mobile phones that have GPS capabilities could be used to track the actual amount of time and the number of visits that subjects make to natural areas.

METS (see below): This provides a system for estimating caloric output for different types of physical activity.

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**METS**

Barbara Ainsworth at the College of Health Solutions at Arizona State University has developed the MET or “Metabolic Equivalent Task” system as a proxy for measuring the caloric expenditure of physical activities. Researchers have developed a comprehensive ranking of different activities. For example, running might burn a certain number of calories per hour, but playing tennis might burn a different amount.

For more information see: http://prevention.sph.sc.edu/tools/compendium.htm, https://chs.asu.edu/content/barbara-ainsworth, and https://sites.google.com/site/compendiumofphysicalactivities/

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**Park Use**

Park use and visitation is an area that has received a lot of attention, as policymakers and planners try to optimize the design and management of parks for healthier communities, and determine how to value national parks. Some ways of measuring park use include the following:

- Observation protocols and systems, like SOPARC (described below), which researchers can use or train others in. These systems attempt to create some sort of standardization and comparability across much broader datasets than are presently available.

- Social media/geotagged photos to estimate park visitation. A 2013 study compared geotagged photos of recreational sites posted on social media to empirical data on visitation at the actual locations and found that this crowd-sourced information could be used as a proxy for metrics like national park visitation rates. (Wood et al., 2013). http://www.nature.com/srep/2013/131017/srep02976/full/srep02976.html

- Tourism dollars may be another way to estimate park visitation.
SOPARC

SOPARC, or System of Observing Play and Recreation in Communities is a system that has been widely used in parks and recreation areas.

Originally developed in 2006 by researchers Thomas Mackenzie and Deborah Cohen, SOPARC collects information not just on the park environment and the number of users, but also demographic information on users’ age, ethnicity, and gender, on the type of activity they are engaged in, and on the accessibility of the park itself.

Active Living Research provides extensive resources on the use of SOPARC and RAND Health has developed a free online and downloadable iPad app along with a training DVD, all available through http://activelivingresearch.org/node/10654 and http://www.rand.org/health/surveys_tools/soparc.html

Health Indicators

Another way to measure health involves the use of health indicators. Health indicators are summary measures used to look at one or more aspects of health of individuals, populations, or environments. They can be used in large surveys to effectively track changes across populations or groups (Allee, 2010).

Many resources exist for health indicators, but more work still needs to be done to separate out the most important ones for this field. U.S. Census data can also be a critical tool in evaluating need and outcomes on a broader scale. However, it poses a major problem in that it has not been consistently collected at the same scale across the country. Some other resources are listed here:

- **Community Health Status Indicators Report**: This 2009 Report from the U.S. Dept of Health and Human services provides some examples of useful health indicators: http://wwwn.cdc.gov/CommunityHealth/homepage.aspx?j=1

- **Health Indicators Warehouse**: This is a source for national-level health data that is already compiled and could be analyzed with an eye to changes in access to green space. http://www.healthindicators.gov/

- **The Health Measurement Research Group**: A collaboration between the National Institute on Aging and the National Institutes of Health also offers a number of standardized Health-Related Quality of Life Measures. For example, the SF-36v2 is a multi-purpose, 36-question survey that touches on mental health, physical health and well-being. It can be self-administered or given by a researcher. http://www.healthmeasurement.org/Measures.html

- **Healthy People 2020**: an initiative of the U.S. Department of Health and Human Services (see discussion in Section 2), tracks the health of the U.S. population based on 26 “Leading Health Indicators” organized under 12 topics, including access to health services, environmental quality, and social determinants. Indicators within these topics

Some health indicators by life stage include the ones outlined in the following chart. Hospitals and foundations may be well positioned to gather and analyze this information at the regional and population levels, with a focus on the ones that are associated with the greatest healthcare costs or the largest health inequities (Ickovics, conversation with author, April 24, 2014).

<table>
<thead>
<tr>
<th>Birth</th>
<th>Childhood/Adolescence</th>
<th>Adulthood</th>
<th>End of Life</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Gestational age</td>
<td>· Self-concept</td>
<td>· Respiratory disease</td>
<td>· Chronic disease</td>
<td>· Age-adjusted mortality</td>
</tr>
<tr>
<td>· Birth weight</td>
<td>· Development</td>
<td>· Mental health</td>
<td>· Cardiovascular disease</td>
<td>· Premature death</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>· Cancer</td>
<td>· Leading indicators of death</td>
</tr>
</tbody>
</table>

Whether using self-reporting, observation, or measurement, stakeholders must divide responsibilities to best suit their own strengths, and work towards the standardization that will make large datasets analyzable. For example, land trusts and park managers might expand on the numbers that organizations like the RAND corporation are gathering on park use to start collecting their own data, while hospitals and health care providers might provide support to land trusts to help gather data on blood pressure and cortisol levels before and after outdoor activity.

### 3.3 What is Already Being Done to Measure Effects?

Building on the overview of measures above, this section outlines some of the research that has built the foundation for our current understanding of how nature and health are connected. For example, Ming Kuo's work at the University of Illinois Laboratory of Health and Human Landscapes (http://lhhl.illinois.edu/) has used a wide variety of measures to describe the effect of nature on people in urban environments. Rachel and Stephen Kaplan at the University of Michigan have also done work on Attention Restoration Theory and the role that spending time in natural areas can play (Kaplan and Kaplan, 2005).

Major methods for measuring health effects from exposure to nature that have been used to date include:
• Standardized test scores examined longitudinally at schools with different ratings of greenness (Kuo, conversation with Author, 2013).

• “Self control” after exposure to green space (Taylor, Kuo, and Sullivan, 2002)

• Severity of symptoms for children with ADHD as reported by parents after a walk in a park (Kuo and Faber Taylor, 2004)

• Performance on a concentration test for children with ADHD after time spent outside (Kuo and Faber Taylor, 2004)

• Violence in housing units with different levels of greenness (Kuo, 2010)

• Cognitive performance (on a number sequence recall test) after exposure to natural images (Berman, Jonides and Kaplan, 2008)

• Psychological distress and global self-worth perceptions in areas with varying levels of vegetation (Wells and Evans, 2003)

Studies of the Japanese practice of “forest bathing” have employed several quantitative measures to compare physiological states before and after spending time in a forest (Williams 2012), such as:

• Cortisol, a stress hormone released throughout the body, the levels of which are sampled in the saliva

• Sympathetic nerve activity

• Blood pressure

• Heart rate

Wilderness therapy and therapeutic experiential education groups have employed psychological tests to measure effects before and after a trip, including:

• Locus of control

• Behavioral symptoms

• Self-efficacy (Davis-Berman and Berman, 1989)

• Rosenberg Self-Esteem Scale (RSES)

• Pearlin Mastery Scale (PMS)

• Social Anxiety and Distress Scale (SADS)

• World Health Organization Quality of Life Scale (WHOQoL-Bref) (Cotton 2013)

Methods used to assess the impacts of outdoor education include

• Self-reported effects (Derr and Kellert 1998)

• “Life Effectiveness Questionnaire” (Neill 2008)
• “Tennessee self-concept scale” (Ewert and McAvoy 2000)
• Differential assessments for different populations (Orren and Werner 2007)
• Long term effects or “far transfer” studied through surveys and interviews (Sibthorp et al. 2008)

Additional research on the impacts of outdoor education on children includes several meta-analyses of the research to date as well as “A Review of Research on Outdoor Learning,” published in 2004 for the U.K.-based Field Studies Council. This review represents an excellent, but not exhaustive, summary of research on outdoor and adventure education from a British perspective: http://www.wilderdom.com/research/ReviewResearchOutdoorLearningRickinson2004.html. Further links to outdoor education research can be found at the end of this chapter.

### Naturebridge

Naturebridge is an environmental education program based in the San Francisco Bay area that runs multi-day science education programs for students of all ages. It has shown a particular commitment to measurement and evaluation of its impacts on participants. It releases a biannual environmental education research bulletin compiling and summarizing the latest research in the field.

More information can be found at: http://www.naturebridge.org/resources

Tools that are being used to evaluate physical activity or the use and availability of parks and recreation spaces include the aforementioned ParkScore, ParkServe, and SOPARC tools, but also:

• System of Observing Fitness Instruction Time – SOFIT (1991) and System for Observing Play and Leisure Activity in Youth – SOPLAY (2000). Both are systems that are similar to SOPARC.

• Checklist for Health Environments at Work – CHEW (2002) – focuses on access to physical activity and natural areas in the work setting

• Short Questionnaire to Assess Health-enhancing physical activity (SQUASH) (Sallis, 2009)


Some land trusts are already leading the way by rating trails and open spaces. For example, as part of the creation of the Red Rock Ridge and Valley Trail System, a plan for an exten-
sive trail network near Birmingham, Alabama, the Freshwater Land Trust worked under a grant from the Centers for Disease Control aimed toward enhancing community health in the area. For each proposed trail, they developed a set of criteria – rating the trail type and design to guide how each trail is built and used. (For more information see Section 1.3 or http://www.redrocktrail.org/)

Similar models could be used to categorize different types of open space and match them to the manner or intensity of activity desired by a user or prescribed by a doctor – as described in the following box:

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**Parkpages**

Dr. Robert Zarr, a physician with Unity Healthcare in Washington DC, has been working with the DC Department of Health to develop a database that provides such information to doctors and the low-income patients who most need it.

Zarr’s “Parkpages” database, which is integrated with the DC Park Rx program, provides a short summary of information about each park, including its proximity, features, and programming. http://www.aapdc.org/prx/ The database is linked to the Electronic Medical Records System, so physicians can have access to it as they are treating patients.

At the same time, every time a parks prescription is written, it is recorded next to other measures gathered at the time like BMI or blood pressure (Zarr, conversation with author, April 24, 2014.). In the future, Dr. Zarr hopes to develop a mobile app and a way to gather biometric data and information on whether or not patients actually go to the parks prescribed (Myrie and Daniel, 2014).

For an NPR story about Dr. Zarr see: http://www.npr.org/blogs/health/2014/07/14/327338918/to-make-children-healthier-a-doctor-prescribes-a-trip-to-the-park

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The following diagram lays out some general methodologies organized across scales of concern and a range of qualitative to quantitative methods that may be used by researchers looking at the connections between health and nature. Stakeholders may choose methodologies based on the type of information that would be most convincing to funders or policy-makers, or on their own strengths in data-gathering.
3.4 Challenges for Measurement

While much important work has been done in this field and ever more exciting studies continue to be developed, significant barriers to research still exist. Critical challenges for measurement include:

- Who will collect the data? Parks are understaffed, while volunteers can be inconsistent and hard to coordinate.
- What equipment is needed and who will pay for it?
- How do we get the data? For logistical reasons there is a bias towards self-reporting.
- How do we avoid a sampling bias, or compensate for it in self-reporting?
- How do we recruit individuals for the study and is there any way to achieve a random sample?
- How do we track individuals over time?
- How will behavior change when people know they are being measured and how do we compensate for this?
- How do we obtain and handle sensitive health information?
• How should we manage and analyze data?
• When is it appropriate to use quantitative measurements, and how do we ensure that the data captured in a qualitative format is equally usable?

A few of these challenges are expanded on below.

3.4.1 Objectivity/Bias

By its very nature, this work is not being conducted in the lab. Thus, it is difficult to control for the diverse variables that affect the connection between health and time in nature.

“There is no such thing as an objective measure,” says Geoffrey Godbey, Professor of Recreation, Park, and Tourism Management at Penn State. In his work on parks, he has found that giving people accelerometers or pedometers inherently changes how they exercise and recreate. There may be a point at which people become so accustomed to wearing a unit that this effect falls off, but he is not sure exactly when that is. In addition, Godbey points out that there is “no such thing as a random sample” in a park. The number of people and the behaviors they display are constantly shifting, even in response to researchers’ manipulations. The demographics of physical activity are affected by many factors, including community infrastructure, safety, affordability, recreational programming, and social ties. (Godbey, conversation with author, March 14, 2014)

Self-reporting is a frequently used methodology for gathering data on stress levels, physical activity, park use, and health status that is relatively cost-effective, but sometimes inaccurate. Parks researcher Andrew Mowen says that self-reporting of physical activity tends to overestimate the actual quantity, often by at least two times (Mowen, conversation with author, March 19, 2014).

Ideally, more than one measure should be obtained for each variable in order to triangulate and normalize for some of these effects. For example, researchers might combine self-reporting with interviewing key informants and wiring up some participants to instruments that can quantitatively measure their activity. Gathering multiple sets of data will help control for bias.

3.4.2 Quantitative Measures and Follow-up

At the same time, even quantitative measurements taken by researchers may be unreliable. For example, cortisol, usually measured from saliva, is expensive to test and according to some researchers, difficult to calibrate because it “jumps around a lot.” Encouragingly, researchers have also found that self-reported stress levels are generally a good proxy for measured stress (Godbey, conversation with author, March 14, 2014).

Obesity and BMI are highly measurable and highly trackable, but they still pose the challenge of how to follow up with people once you have measured them. (Godbey, conversation with author, March 14, 2014) Even studies that attempt to gather a random sample by measuring people at a park run into challenges when trying to track individuals’ health
over a longer term. For example, people like having their blood pressure taken on-site for free, but it is hard to get either their prior information or follow up with them afterward to look for longer-term effects of outdoor recreation. All these instrumental measures are also confounded by other variables that might be affecting measurements, such as medications, preexisting high blood pressure, or other conditions.

### 3.4.3 Scale and Availability of Data

According to Breece Robertson of the Trust for Public Land, one of the biggest challenges she encounters as she works with different park mapping models is the scale and availability of data.

Most health data exists at the county or state level right now, so it is very difficult to analyze it down to the level of the individual or even of a local community. Meanwhile, TPL’s current work looks at the effects of individual parks, but there is no way of scaling up, because based on the available data one cannot meaningfully extrapolate to the whole park system to see how people are being served by it (Robertson, conversation with author, April 14, 2014). Therefore, better analysis must be preceded by efforts to fill in the relevant information at the appropriate level (census-block, county, or individual geo-coded address).

Even if this data exists, however, researchers may not be able to gain access to it. Local health departments usually cannot share the data they gather, and many hospitals are unable to give access to confidential health information. In some places, researchers have been able to get past this hurdle by obtaining access to aggregate data, or by asking people to self-report on their own health.

Hartig et al. also point out the current limitations in connecting disciplines like epidemiology and psychology that are fundamentally concerned with different scales — in this case the population or the individual, respectively. In the future, gaining access to reliable data at multiple scales and connecting it in a meaningful way for interpretation will be critical to nature-health research.

### 3.4.4 Entangled Variables

Physical activity and time spent outside are not discrete variables. Their effects are often hard to distinguish from one another. In the long term, more intervention studies are indicated in order to try to isolate variables to see how they affect outcomes. Intervventional and longitudinal studies may help disentangle some of these issues over time.

### 3.5 Solution Spaces for the Future

The future of research on the connection between nature and health is both promising and full of opportunity. New policy standards like health impact assessments or community health needs assessments are continuing to open the way for researchers to gather baseline
data for tracking future changes related to green space interventions. At the same time, tools like personal technology are making it ever more possible to work with and gather data at the individual level.

An approach that combines tapping into health data that already exists and gathering original data for further studies will be crucial to strengthening our understanding of these connections.

### 3.5.1 Health Impact Assessments

Health Impact Assessments (HIAs) have now become standard as part of the planning and approval process of many projects, driven by a need to assess health inequalities and account for human impacts (World Health Organization, 2014). HIAs offer a way to assess the community health impacts of projects, policies, or programs, often using publicly accessible health data. The National Park Service offers an HIA workbook and planning tool for parks and trails that guides users through creating a community health profile, gathering data for a site, planning and designing the trail or park, and creating a system for monitoring and evaluation: [http://www.healthimpactproject.org/hia/us](http://www.healthimpactproject.org/hia/us)


### 3.5.2 Data Access

William Bird of Natural Health England suggests that many opportunities may exist to work with existing data or health data that is still being collected, rather than starting projects entirely from scratch (Bird, conversation with D. Krause, 2014). For example, existing healthcare cost information from insurance companies or hospitals may be useful even as new data is gathered. This may prove especially important in light of the fact that while funding cycles for research on interventions may be only three to five years, some effects of nature on health, especially at the population level, may take much longer to be revealed (Hartig et al., 2014).

Professor Jeannette Ickovics of the Yale School of Public Health and the Community Alliance for Research and Engagement (CARE) has recently started working with a Connecticut healthcare database called CHIME, which has a record of 31 million patient encounters, including emergency room use, outpatient visits, and inpatient stays, dating back to 1980 and geocoded down to individual street addresses. She hopes to be able to look at change in health indicators over time, eventually linking those changes to amounts of greenspace in different neighborhoods (Ickovics, conversation with author, April 24, 2014).

The cost of health care is a central question in this puzzle and may also be usable as a proxy...
for health indicators. Ickovics is working with the Health Care Costs Institute (HCCI: http://www.healthcostinstitute.org/) to analyze spatial, geocoded data on medical service use and determine how different variables might be interacting. HCCI provides access to information on health care utilizations and costs for 10 million people in the U.S. who use private insurers like Kaiser, Aetna, or United Health Care. In the future, Medicare data could prove to be especially useful for tracking the vulnerable and underserved populations Ickovics is studying.

For Ickovics’ preliminary work in this field, hospital billing data is proving to be some of the most compelling evidence for the effects of green space on health. In the future, she hopes to connect maps and green space data to information about birth outcomes, mental health status, and substance abuse. As she points out, a tremendous amount of information, such a codes for health conditions, exists at the aggregate level and could be used to learn much more about utilization and costs (Ickovics, conversation with author, April 24, 2014).

**Health Care Hot Spots**

Healthcare “hot spotting,” is a new approach in health care that tries to improve efficiency and reduce costs by mapping hospital billing data to find out where the “hot spots” of high cost patients are. The approach focuses on “high utilizers” — the 5 percent of patients who account for more than half of healthcare costs. These patients typically have complex medical conditions compounded by social issues.

Dr. Jeffrey Brenner and the Camden Coalition of Healthcare Providers in New Jersey piloted a method to offer more targeted and collaborative care that in some cases reduced costs by more than half per patient. The Robert Wood Johnson Foundation is now helping to disseminate this approach to other areas of the country.

Hotspot maps could be overlaid with maps of access to green space either to visualize areas of high need or to identify possible health treatments in the form of a nearby park or trail.

For more information on hot spotting see : http://www.rwjf.org/en/research-publications/find-rwjf-research/2012/03/hot-spotting-leads-to-better-care-at-a-lower-cost.html

The PewResearch Internet Project suggests another opportunity to gather data: according to a recent Pew telephone survey, 69% of all U.S. adults track a health indicator for themselves or a loved one. These indicators include weight, exercise routine, diet, or symptoms of a chronic condition like high blood pressure or diabetes. People living with one or more chronic condition were found to be significantly more likely to track their symptoms.

The fact that many individuals are already keeping track of their health suggests that there is a tremendous opportunity here for participatory research on the effects of outdoors time
on commonly used health indicators. At the same time, it is also clear that a huge amount of daily individual health data already exists that could be analyzed and processed. This data, while it may be less “objective” than that gathered by researchers, has the advantage of being collected more frequently. It simultaneously offers a potential longitudinal perspective if correlated with known events, such as the regreening of a neighborhood.

Overall, people surveyed by Pew monitored their health data by keeping track “in [their] head[s],” by writing things down, or by using some sort of technology, including a proliferation of cell phone apps that have developed for the specific purpose of helping people manage their health (Fox and Duggan, 2013). Access to any of these personal data sets in the future will have to be managed in a manner that is both sensitive and secure.

UCLA Center for Health Policy Research: the California Health Interview Survey

The UCLA Center for Health Policy Research conducts the California Health Interview Survey, the nation’s largest state health survey.

The CHIS is a telephone interview study that asks 10,000 Californians a series of question about their health. Policymakers and researchers then work with this data to generate algorithms that they can extrapolate, and the data is ground-truthed to verify if they are actually getting an accurate cross-section of the population.

Datasets like this one have the advantage of being localized, lending themselves well to research.

For more information see: http://healthpolicy.ucla.edu/chis/Pages/default.aspx

3.5.3 Community Health Needs Assessments:

Community Health Needs Assessments provide a fantastic opportunity to establish baselines and focus our efforts for improved outdoors access in the communities that need it the most.

Yale-New Haven Community Health Needs Assessment and the Greater New Haven Community Index

As mandated under the Affordable Care Act, health care providers like the Yale-New Haven hospital system are required to conduct a Community Health Needs Assessment (CHNA) or be subject to a $50,000 annual fine.
Yale-New Haven contracted with the Community Alliance for Research and Engagement (CARE), headed up by Jeannette Ickovics at the Yale School of Public Health, to conduct a comprehensive assessment of health in its communities. The report was one part of the Greater New Haven Community Index 2013, a survey that took a broader look at strengths and opportunities in New Haven, and was coordinated by DataHaven, an organization that uses data for community action. For the Health Needs Assessment, CARE representatives went door to door in neighborhoods throughout New Haven and administered surveys that asked interviewees a number of categorical, quantitative, and qualitative questions about their social and economic situation, health status, habits, and hospital utilization.

Such CHNAs will be critical for assessing both health needs and nature impacts in the future. Future iterations of CHNAs could incorporate questions about access to green space into the questions about physical activity and health that are already used. At present, the New Haven CHNA provides an excellent baseline from which to look at future interventions.


Studies similar to the New Haven assessment are currently being conducted across the country. The result will be a number of usable datasets that will be regularly revised, and whose protocols should be updated as soon as possible to incorporate open space considerations as a component of community health.

3.5.4 Personal Technology

Perry Robinson, a physician recently hired by the Open Space Institute to help deepen the connections between open space and health, points out that many people in the U.S. carry smartphones, which are constantly engaged in the passive collection of data like GPS coordinates. He notes the recent growth in the “wearables” movement—small electronic devices that can connect to your phone and monitor everything from the number of steps you take, to variability in your heart rate.

From Fitbits to pregnancy trackers, technology provides an opportunity to both quantitatively measure health indicators and to organize qualitative information in a way that makes it easy to track trends. Soon, an app on your phone may even be able to predict a heart attack before it even happens (Robinson, conversation with author, April 26, 2014).
Scanadu

Scanadu is a startup that designs personal health scanners to measure everything from temperature to blood pressure to stress. The Scanadu Scout is a biscuit-sized scanner that, when held to the forehead, captures physiological data in the moment and tracks trends over time. Currently under development is the Scanaflo, an at-home urine test kit that will test for levels of bilirubin, pH, and other indicators. The devices are part of a movement to personalize health care and put more information into the hands of patients themselves, while facilitating better communication with healthcare providers.

For more information see: https://www.scanadu.com/

The data gathered by devices or apps like Scanadu is currently proprietary information whose use would raise concerns about privacy. However, as Robinson points out, such technology also offers the potential to “gamify the process of going outside,” motivating people to recreate through competition, setting health goals, and playing games. (Robinson, conversation with author, April 26, 2014)

3.5.5 Longitudinal Data and Intervention Studies

Longitudinal and interventional studies are necessary for better understanding how nature impacts health in the long term. Studies should be done to measure changes in the physical environment as well as impacts on people. For example, if there is a change to the physical environment – such as creation of a new trail nearby – can we also document changes in health before and after the change has been made?

The initial work for these studies involves establishing a baseline so that changes may then be detected. For example, at a given park or natural area, one should look at the use of the site before and then after changes like increased programming, landscaping, a river cleanup, or even increased degradation of the environment. (Mowen, conversation with author March 19, 2014).

The Central Park Study

Large scale, participatory studies have been conducted in Central and Bryant Park in New York City to count users of the park and describe their activities. The hope is that in the long term, longitudinal data will demonstrate the positive impacts of increased user programming over time.

For the Central Park Report see here: http://www.centralparknyc.org/assets/pdfs/surveyreport_april2011.pdf
Assessing Park Renovations

TPL, the San Francisco Department of Public Health (SFDPH) and the RAND Corporation are collaborating on a study of three parks in underserved San Francisco neighborhoods that are being renovated to see if there will be demonstrated changes in physical activity. Pre-renovation studies were completed in 2009, and post-renovation studies, which included the use of SOPARC and SFDPH environmental assessment tools like the Healthy Development Measurement Tool and the Pedestrian Environmental Quality Index, wrapped up in 2012. Results showed a significant increase in use and perceptions of safety in the renovated parks.


Professor Andrew Mowen at Penn State University is currently looking at the effects of park renovation in Philadelphia on visitation, health and social capital. Professor Mowen focuses in particular on the outcomes of collective efficacy, social cohesion, and informal social control, as well as the role of park design in creating a sense of place and connection to the outdoors. This work follows up on another study that he conducted in Allentown, Pennsylvania that surveyed people to ask them about their physical activity and perceptions of the park. The Allentown study showed a significant positive increase in both these indicators post-renovation.

Before and after studies of parks that are being renovated in places like Philadelphia or San Francisco are important because they provide the opportunity to compare against a known baseline and help us understand how we might target interventions to provide better health for people.

Currently most work in this area is being done on public parks and land. Private land might be a new avenue for research, providing the opportunity to start baseline studies in a place where accessibility to a certain piece of land has just increased.

The final step will be incorporating this information into outcomes-based or evidence-based design, such as those principles being promoted by the Therapeutic Landscapes Network: http://www.healinglandscapes.org/blog/2012/04/evidence-based-design-accreditation-and-certification-edac-why-it-matters/

3.6 Conclusions

The impact of nature on health is and will continue to be a growing area of research, developing ever more refined techniques for measurement and ever more effective ways of analyzing data. In the process, as we develop a more thorough understanding of the pathways by which these effects happen, many more questions will emerge, each with their own challenges and opportunities. On one end of the spectrum, we may one day be able to quantitatively track the effect of a “dose” of nature all the way down to the cellular level in the human body. On
the other end, we will need to develop more comprehensive qualitative measurements that allow for better comparisons between treatment groups without losing the variation that accurately captures differences in experience at the individual level.

Jeannette Ickovics notes that at the same time, we should also consider a case study approach. It is critical to keep our target audiences and end policy goals in mind in the course of research. This will push us to produce not just hard numbers and statistics, but also “readily understandable data with an emotional appeal” that can be used in outreach to many audiences, from community members to health providers to Congress (Ickovics, conversation with author, April 24, 2014). Measurement must be both rigorous and specific, compelling and understandable.

Moving forward, we must continue to expand efforts to bring people together to measure health outcomes from outdoor recreation— from the scientists who can break it down to the outdoor users who do it. Peter Harnik of the Trust for Public Land points out the classic Catch-22 of funding for parks departments. Park managers want to gather this data, but they do not have the staff or the money. In contrast, departments like the Department of Transportation tend to have lots of data and it helps them get more funding (Harnik, conversation with author, April 8, 2014). Park departments would do well to follow this model.

As private entities working with funders, land trusts can play a crucial role in helping to collect this data and turn it into the evidence needed to tie together the goals of access to nature and improved health. Creative partnerships among citizen groups, parks, foundations, health providers, academic institutions, and many others could help build the capacity needed to gather this data and turn it into real change. Only with this sort of cooperation will we be able to create the critical body of research needed to maximize the benefits of health from nature.

**Possible Questions for Discussion**

- What roles can land conservation organizations usefully play in research on nature and health?
- What about health organizations?
- How and where should funders direct their support for this type of research and action?
- What types of data have the most credibility with the health care community? What about with funders, with policy makers, or other stakeholders?
- What kind of data is already out there that could most readily be used for this research? What new types of data still need to be produced?
- What types of data can be collected by physicians, hospitals, park rangers, foundations, and other stakeholders?
- What level of conservation/access to natural areas is needed to achieve change?
Useful Informational Links/Places Doing Interesting Work

TOOLS, METRICS, & GUIDELINES FOR MEASUREMENT

• **Active Living Research: Tools and Measures**: [http://activelivingresearch.org/toolsandre-sources/toolsandmeasures](http://activelivingresearch.org/toolsandre-sources/toolsandmeasures)

• **RAND Health** clearinghouse of research on parks, obesity, and other topics: [http://www.rand.org/topics/urban-parks-and-recreational-facilities.html](http://www.rand.org/topics/urban-parks-and-recreational-facilities.html) and [http://www.rand.org/topics/health-and-health-care.html?tag=Obesity](http://www.rand.org/topics/health-and-health-care.html?tag=Obesity)


• **Healthx Design** is a company headed up by metrics whiz Rupal Sanghvi that focuses on outcomes-based design: [http://healthxdesign.org/](http://healthxdesign.org/)

• The **Centers for Disease Control and Prevention** maintains a dataset on community design elements, including public spaces, and their health effects. [http://ephtracking.cdc.gov/showMonitoringElementsOfCommunityDesign.action](http://ephtracking.cdc.gov/showMonitoringElementsOfCommunityDesign.action)

• **National Recreation and Parks Association Research**: [https://www.nrpa.org/research-papers/](https://www.nrpa.org/research-papers/)


HEALTH IMPACT ASSESSMENTS

• **Active Living Research: Health Impact Assessment**: [http://activelivingresearch.org/health-impact-assessment-resources](http://activelivingresearch.org/health-impact-assessment-resources)


• **CDC Parks and Trails Health Impact Assessment**: [http://www.cdc.gov/healthyplaces/parks_trails/default.htm](http://www.cdc.gov/healthyplaces/parks_trails/default.htm)


RESOURCES FOR HEALTH DATA

• The **Behavioral Risk Factor Surveillance System** is a state-based system of health surveys that provides information at the city, county and state levels on risk factors including diabetes, cardiovascular disease, physical activity, and obesity: [http://www.cdc.gov/brfss/](http://www.cdc.gov/brfss/)

• The **CDC Chronic Disease Indicators** website offers primarily state-level information for 97 health indicators and allows users to collect and report data on chronic disease: [http://apps.nccd.cdc.gov/brfss-smart/SelMMSAPrevData.asp](http://apps.nccd.cdc.gov/brfss-smart/SelMMSAPrevData.asp)
• **Sortable Stats 2.0 - Interactive Database for Behavioral Risk Factors and Health Indicators**: A CDC website offering information at the regional and state level on death rates by disease, disease burden, risk factors and preventive services: [http://wwwn.cdc.govsortablestats/](http://wwwn.cdc.gov/sortablestats/)

• **The Environmental Public Health Tracking Network**: [http://ephtracking.cdc.gov/showHome.action](http://ephtracking.cdc.gov/showHome.action)

• **The National Center for Health Statistics** may also be a useful source of indicators that could be used in this work: [http://www.cdc.gov/nchs/](http://www.cdc.gov/nchs/)

**OUTDOOR EDUCATION**


• Part of the [wilderdom.com](http://www.wilderdom.com) website serves as a clearinghouse for quite a bit of outdoor education research. Here they provide a partial list of organizations and universities that are engaged in outdoor education research: [http://www.wilderdom.com/research/organizations.html](http://www.wilderdom.com/research/organizations.html)

• **Research Meta-analyses**: This is a summary of several meta-analyses of outdoor education research: [http://www.wilderdom.com/research/ResearchReviewsMetaanalysis.html](http://www.wilderdom.com/research/ResearchReviewsMetaanalysis.html)

• For general **Outdoor Recreation Research Information**: [http://www4.ncsu.edu/~leung/recres2.html#univ](http://www4.ncsu.edu/~leung/recres2.html#univ)

• **University of Michigan study**: Studying the effects of environmental education for elementary school students: [http://meera.snre.umich.edu/reports-and-case-studies/effects-outdoor-education-programs-children-california](http://meera.snre.umich.edu/reports-and-case-studies/effects-outdoor-education-programs-children-california)

• **Kellert and Derr**’s paper provides a particularly valuable resource in the form of an annotated bibliography from pages 78-104: [http://www.childrenandnature.org/downloads/kellert.complete.text.pdf](http://www.childrenandnature.org/downloads/kellert.complete.text.pdf).

**HEALTH INDICATORS**


• **Health Indicators Warehouse**: [http://www.healthindicators.gov/](http://www.healthindicators.gov/)

• **The Health Measurement Research Group**: [http://www.healthmeasurement.org/Measures.html](http://www.healthmeasurement.org/Measures.html)

Useful Reading/Works Cited


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